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EDITORIAL NOTES.

THE instability of warships has probably been a matter of growth and evolution, like many other things. The desire to raise the firing-point of heavy guns as far above the water-level as possible, the use of heavily armored turrets, and the increasing weight of the military masts with their protected tops have so raised the center of gravity of the vessel that the stability has been sacrificed. It seems hardly proper to put a gun on a platform which has such a tendency to roll that accurate aiming is impossible, merely for the sake of a few feet of elevation above the water-line.

THE iron car has had a long pull and a hard pull in getting itself admitted into the favor of railroad men, but the time seems to be near at hand when it will be regarded as an essential part of the rolling stock. Heretofore the great expense attending its construction and the more than doubtful saving in maintenance has kept it out of the race. But such reports as those furnished by Mr. Joughins, on the cost and repair account of the iron cars which he has had in service, will go far toward removing prejudice from the minds of the men in charge of the car departments, and opening the way for the general introduction of these cars for some kinds of freight.

THE newspapers have been commenting very widely of late on the practice of paying speed premiums on war vessels. While the practice was certainly one to have been commended when it was first introduced by Secretary Whitney, as American builders did not know what they could do, it does seem that now if the Government wants a 20-knot vessel it should contract for it direct, and not invite bids for an 18-knotter with a privilege granted to the builder of making the speed 20 knots and get a premium of $200,000. It certainly favors the builder and allows for laxity, for we take it for granted that a 20-knot speed is wanted when 18 is asked for. American builders do not need this coddling any longer; they know what they can do, so the reason for the premium system appears to exist no longer.

THE instability of some of the warships of the English and United States navies has been brought prominently to the attention of the public during the month that has passed. The Naval Board have reported against two of our own vessels, and recommended heroic measures for the remedying of the difficulty. The English vessel *Resolution* has, according to all reports, had a narrow escape from capsizing in the Bay of Biscay. The question naturally arising from these two events is, "Who is responsible?" To this there seems to be no answer forthcoming. Professional courtesy reigns supreme, and the designer, whoever he may be, is sheltered behind this cloak. Perhaps no good would be accomplished by making this name public, but the Navy Department should take very good care that he designs no more ships.

THE probability is that the conventions of the Master Car-Builders' and Master Mechanics' Associations, which are to be held at Saratoga in June, will be a notable success from the standpoint of the exhibits which are to be presented. Already the committee in charge of the local matters is making preparations for the installation of exhibits, and it is announced that there will be a line of shafting in motion from which power can be taken for driving machine or other tools. This is a step in the right direction, and one that will be appreciated by those who have made individual attempts in time past to provide a means for operating machinery. The results obtained have been so unsatisfactory that it is very rarely that a second attempt has been made, but with a line of shafting driven by a suitable engine there will undoubtedly be a fine exhibition of machinery in motion.

MEETING OF MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ON another page we give a report of the proceedings of a first meeting of members of the Society of Mechanical Engineers for the discussion of subjects pertaining to their occupation. This meeting to a certain extent was an experimental one, and was held as a sort of sequence to a discussion which was first commenced in these pages. The meeting was generally considered a success, and the encouragement offered to its projectors and those in attendance will lead to a continuance of the meetings, and it is hoped will ultimately make them a permanent feature in the proceedings of this Society, or rather of its members. That such meetings may be made sufficiently interesting and profitable to induce members to attend them was shown in this first assemblage, and the discussion of the subject which was presented. The attendance was very good, the hall of the Society being nearly filled. The regular date for holding the meetings is the evening of the second Wednesday of each month. This date will fall on February 14, when the same subject that was considered at the last meeting—the Development of Stationary Engines as illustrated by those exhibited at the Columbian Exhibition in Chicago—will again be discussed. Mr. Charles T. Porter will introduce the subject, which will afterward be open for general discussion.

As will be seen from the introductory remarks of the chairman of the Committee in charge of the meetings, they will be conducted in a very simple way. As far as practicable it is the purpose to ignore "cranks" and mathematics. At least some of the members of the Committee are of the opinion that engineers should use mathematics as they say their prayers—that is, it should be done in private. The Committee will aim to make these meetings occasions for presenting the ripest fruits of the experience and knowledge of the members of the Society and their associates.

A CRITICISM FROM HEADQUARTERS.

In the announcement of our purposes and intentions for the year 1894, which was published in the December number of The American Engineer, in speaking of our monthly record of accidents to locomotive engineers and firemen, it was said that "its object is to call the attention of railroad managers especially, and the public generally, to the terrible amount of pain and agony, the suffering and bereavement, and the sacrifice of life and limb which goes on daily on our railroads, almost unnoticed and certainly unheeded. We hope to awaken public indignation and to arouse railroad managers to the exertion of some intelligent effort to diminish this sacrifice of life, and the inexpressible torture to which men are often subjected for no other reason than that they have faithfully performed their duties."

This paragraph has been the subject of some criticism, and a railroad officer writes, asking whether we "have any idea that the attention of railroad managers will be any more effectually called to these matters than it now is in their daily routine of business?" He also inquires whether we "know of any railroad manager who is so hardened that he is not willing to consider and adopt any practical device for the purpose shown?"

The criticism is a fair one, and we have therefore read over our quoted paragraph several times to see wherein, if at all, it should be altered. Reflection has suggested the change of one word. If the paragraph were unwritten or unprinted, the word "more" would be substituted for "some." As it now reads, the implication is that railroad managers do not exert *any* intelligent effort to diminish the sacrifice of the lives of engineers and firemen. That is unjust. If we were shaping that sentence into language anew, it would be said that "we hope to awaken public indignation and to arouse railroad managers to the exertion of *more* intelligent effort to diminish this sacrifice of life."

To the question of our correspondent about railroad managers, we feel compelled to answer that we do know of railroad managers who are unwilling to adopt practical devices for saving life. The recent accident on the Delaware, Lackawanna & Western Railroad is a melancholy example. It would not be necessary to go far to find others, and it has happened over and over again that only the sad teaching of calamity, the force of public opinion, or the strong arm of the law has made managers willing to adopt practical devices. It is not so many years ago that it required repeated accidents on a very prominent railroad, which carries passengers to and from New York, to adopt air-brakes on its trains, and on the same road it required an awful calamity, which came in the form of a personal bereavement to those in authority, to induce them to realize the need of block signals on that same line.

Now this reluctance to adopt practical devices is not because railroad managers are "hardened," as our correspondent expresses it. They are not. Some of the most tender-hearted and sympathetic persons we have ever known—and among them is our correspondent—have been railroad managers, and it is safe to say that they all realize their responsibility to an extent that is impossible to those who often criticise them hastily. But the motives of action of a railroad manager, like those of most other human beings, are very complex, and have added to them all the intricacies of the organization over which he exercises control. Life and all its duties and perplexities would be very much easier if we could all know exactly what we ought to do. That word "practical," which our correspondent uses, may embrace a great many of our difficulties. We encounter it constantly in our personal, our social, our business, and our political relations. To know what is practical and what is not is often our great difficulty. Even in shaping these few sentences, the question is constantly arising whether a given form of sentence or selection of words is practical—that is, will it express clearly what is in the writer's mind? On the Delaware, Lackawanna & Western Railroad the President and General Manager apparently don't think that block signals are practical. In the early days of railroading in which they were trained such signals were not essential, but gradually year by year traffic increased, until almost unconsciously a condition of things has been reached under which the trains cannot be moved safely without such signals. In the mean while, these gentlemen have been growing old, and with advancing years an aversion—which comes to all of us—to adopting new ideas has gradually taken possession of them, and the avenues to their minds through which new ideas and conviction should find an entrance have been contracted.

The fact is that "practical" devices for preventing accidents are not always obvious, and this is particularly the case with the class of accidents which happen to engineers and firemen. They have not been studied with a sufficient amount of care to indicate how they may be prevented. When passengers are killed or injured it attracts public attention, and there is an investigation of some kind, with suggestions for prevention in future; but when an engineer or fireman is killed, it is accepted as a necessary concomitant of the operation of a railroad.

One of the objects for which our monthly record of accidents to engineers and firemen is published is to bring them together so that they can be analyzed and classified, and we have entertained the hope that from these records it might be possible to discern the causes of different kinds of casualties, and thus see in what direction a remedy should be sought. That there is a constant sacrifice of the lives and limbs of engineers and firemen on our railroads no one doubts. Why is it not prevented? Because no practical way is apparent to our managers of doing it. Who is prepared to say that prevention, or at least mitigation, is impossible? Our purpose is to indicate the means, if that can be done, and to stimulate other people to do so, if that be possible.

It may not be amiss to suggest certain directions in which railroad managers might look for means of preventing such accidents. Attention has been called in these pages many times to the insufficiency of the steps on locomotives and tenders, and it is a gratification to be able to say that several of the builders of locomotives have acted on these suggestions, and that now the Schenectady and the Brooks and other locomotives have large, liberally proportioned steps, conveniently located, and easily accessible. There are, however, thousands of locomotives running with steps which invite accident, and we have never heard of a railroad manager ordering one of them removed and a better put in its place.

Our accident reports bear frequent testimony of the occurrence of that class of accidents in which engineers and firemen are scalded. Now, an ordinary locomotive boiler has more holes in it than the top of a pepper-box. These are intended for and receive the various cocks, gauges, valves, and other attachments which are essential to the operation of the boiler and the locomotive. In accidents these are likely to be knocked off, which releases the steam or hot water, and thus men pinioned in a wreck are often slowly or rapidly scalded to death, or tortured so that death would be preferred. Now, is there anywhere on any road or in any locomotive shop any effort being made to reduce the risk to this class of accidents? There are, we know, several kinds of check-valves manufactured, and are being introduced to a limited extent, which are located inside of the boiler, so that if in a collision the check-valve or its case is broken off the hot water and steam cannot escape. The terrible accident which occurred on the Pennsylvania Railroad about 12 or 15 years ago at Pi tsburgh will be remembered. In this a train from Pittsburgh ran into the rear end of a stand-

ing local train. The locomotive telescoped into the rear car, which was filled with passengers. In doing so the check-valve and its case was broken, and the contents of the boiler were discharged into the car, scalding a large number of passengers to death. The inside check-valve has been designed to guard against such accidents, and has been pronounced a "practical device" for the purpose, yet it is quite safe to say that it has been adopted on comparatively few roads. That it would be possible to protect some or all of the other openings in a boiler by similar means, or by skillful designing largely diminish the number of openings required, we think is a safe assertion; and yet who is doing it?

In many of the recent locomotives, too, the space in which the engineer and fireman must work is so contracted and inconvenient that no human being should be asked to occupy them. The men are often so hedged in that escape is impossible in the face of impending danger.

Not an unusual cause of injury to the men on the engines in accidents is that in collision or derailments the tender is forced or jumps up on the foot-board of the engine, or the tank breaks loose from its fastenings, or if it does not, the coal is discharged as from a catapult on to the unfortunate men on the engine. Now it is submitted that it would not be a difficult mechanical problem to devise some means which would hold the tender-frame in its place, and prevent it from mounting on the foot-board of the engine. Mr. Blackstone, on the Chicago & Alton Railroad, has for years used a device of that kind on his passenger cars. It is effectual and not expensive and therefore practical, and yet it has never been applied to engines and tenders.

To get a realizing sense of the danger to which the men are exposed on locomotives, let any one imagine that the tank and its contents and the coal on the tender, of an aggregate weight of, say, 50,000 lbs., was suspended by a frail attachment at a height of, say, 50 ft. overhead. The imminence of the danger is apparent, if the attachments which hold this weight should break. The velocity which this weight would acquire in falling 50 ft. would be just about 40 miles per hour. Now when running at that speed on a locomotive, the momentum of the tank and coal would be just as deadly, if the engine should be suddenly stopped by a collision or derailment, and the attachments of the tank to the tender-frame should break, as it would be if they fell on the engineer and fireman from a distance of 50 ft. above them. All that is interposed to the occurrence of such a disaster, in cases of collision, is the fastenings of the tank to the frame of the tender. It will require a good deal of temerity for any one to say that these are as strong as they easily might and should be made.

It is not believed that railroad managers are "hardened," nor that they are indifferent to the safety of their men but, like the rest of mankind, they often are not able to see or to know what measures are "practical," and the mental inertia which weighs down the whole human race exerts its force on them as it does on all the rest of us. To bring about a reform of any kind a great deal of intelligent "hustling" is always demanded, and before we can set things right it is important to know to what extent they have gone wrong. This service, it is thought, our reports of accidents to engineers and firemen may perform.

NEW PUBLICATIONS.

THE ELECTRIC WORLD has also assumed a new suit of clothes with the new year. Its size is now 9¼ × 13 in., which is much more convenient than the old form. It may be noticed that when the fickle goddess smiles on our cotemporaries, they immediately try to emulate the good example which THE AMERICAN ENGINEER has continually aimed to establish. Fellow-cotemporaries, we are now all three of a kind. May the mantle of peace and prosperity be upon all of us.

THE TRADESMAN, published semi-monthly in Chattanooga, comes to us in a new form which is now almost exactly the size of THE AMERICAN ENGINEER. It, *The Tradesman*, has all the appearances of prosperity. Whether its proprietors are correspondingly happy we have no means of knowing, but it seems as though they ought to be.

A THOUSAND-MILE RIDE ON THE ENGINE OF THE SWIFTEST TRAIN IN THE WORLD. *From New York to Chicago in the Cab of the Exposition Flyer.* By Cy Warman, formerly engineer on the Denver & Rio Grande Railroad.

The above is the imposing title of an article in *McClure's Magazine* for January. It is written in the current newspaper style, which is a little hysterical. It is illustrated with engravings of various kinds one very excellent one of the reproduced *De Witt Clinton* and train, which has been published so much and so often. The celebrated 999 and her train is also very well engraved. Not so much can be said of some of the portraits. The writer of this notice is well acquainted with Mr. Buchanan, Superintendent of Machinery of the New York Central Railroad, and he, the writer, can bear personal testimony that his hands are not as big and his head is not as small as they are represented in his portrait in this article. The kind of pictures which newspapers publish of people make one long for an extension of the copyright law, so that we may have our faces copyrighted and thus prevent such misrepresentations being published.

The article is popular and readable, which is about all that can be said in its favor.

ON FORMULAS FOR PILE-DRIVING. By Charles Haynes Haswell, M. Inst. C.E. For nearly 40 years a copy of "Haswell's Engineers' and Mechanics' Pocket-Book" has been a companion of the writer. This copy was published in 1855, and is well worn and soiled. It opens of itself at the places which have been oftenest referred to, among these being the tables of areas and diameters, which are nearly worn out. The author of this book is now 84 years of age, and may be met any morning walking to his office with a vigor and elasticity which some of us who are a generation younger may envy. It will, perhaps, come as a surprise to some of our readers to have a new paper by this same author. The little pamphlet before us is a paper of six pages submitted to the Institution of Civil Engineers. In it he has attached the formulæ of other writers, and has evolved one of his own. Many of us will hope that Mr. Haswell may write still another paper and give in it the formula for perpetual youth, which he apparently has discovered.

NOTES ON THE TESTING AND USE OF HYDRAULIC CEMENT. By Frederick P. Spalding, Assistant Professor of Civil Engineering, Cornell University, Ithaca, N. Y. Andrus & Church, Ithaca, N. Y. 6¼ × 4¼ in., 108 pp.

The notes embodied in this little book, the author says, "were designed for use as a text in a short course of instruction, as well as to serve the purpose of a handbook in the laboratory." It consists of three chapters on the Nature and Properties of Cement; Cement Testing; The Use of Cement and the Literature Relating to Cement.

A new book is somewhat like, and in fact is a new acquaintance, and the reader is influenced by it somewhat as he is when he meets a stranger. Some people and some books keep us at a distance, while others at once seem to take us into their confidence. The book before us is one of the latter kind. The author begins by telling the reader in the simplest and clearest way what hydraulic cement is, describes its properties, how it hardens or sets, and the peculiarities of this process under different conditions. The second chapter describes the object of testing it, the qualities, such as weight and specific gravity, fineness, rate of setting, tensile strength, soundness, chemical ingredients, etc. The methods of making such tests are also described in an admirably clear style, which the reader follows without an effort, and is as much entertained, and a great deal more instructed, than he is in reading a newspaper article. The third chapter tells us of the use of sand and water in mortar, mixing mortar, concrete, and lime and cement, the effects of freezing on mortar, its porosity, permeability, expansion, and contraction.

The last chapter gives a list of literature relating to hydraulic cement in English, French, and German. The author says that only such papers have been included as seem to possess some definite value for purposes of research. This feature of the book is a very valuable one.

Altogether these "notes," which Professor Spalding has given to the public, may be highly commended, and it may

be said of them that he has "so presented his ideas that they may be apprehended with the least mental effort," instead of clouding them in circuitous phrases and intricate mathematics, as seems to be the fashion of late in the writing of technical books.

ELEMENTARY LESSONS IN STEAM MACHINERY AND THE MARINE STEAM-ENGINE, *with a Short Description of the Construction of a Battleship.* Compiled for the use of junior students of marine engineering, by Staff Engineer J. Langmaid, R.N., and Engineer H. Gaisford, R.N. New edition, revised and enlarged. London and New York: Macmillan & Co. 8¼ × 5½ in., 261 pp.

These "Elementary Lessons," the authors tell us, "were prepared for the naval cadets in H. M. S. *Britannia*, and represent a systematic course of simple instruction preparatory to a more thorough study of the whole subject."

Under the guise of this rather formidable title and pretentious announcement, the authors and publishers have given the public a lot of what may be called engineering twaddle, and if this is the basis, as the authors say it is intended to be, of the instruction of the naval cadets in H. M. S. *Britannia*, they are deserving of sympathy.

As an example of the sort of intellectual food prepared for them, the following is an example: "In constructing steam or other machinery, measurements are usually made in *feet, inches, and fractions of an inch*, and these measurements must be very accurate and exactly adhered to." Are the cadets in the British Navy in the habit of thinking that steam machinery is measured by the yard, furlong, mile, or French meter?

Again it is said: "Cylindrical surfaces are measured by gauges, 'ring,' and 'plug,' similar to those represented in fig. 1." This is not true; such gauges are not used for measuring cylindrical surfaces, but only as standards of reference, from which the correctness of the measuring tools or instruments may be verified.

"Truly flat surfaces," it is said, "are insured by the use of 'straight edges' and 'surface plates.'" If the authors had here explained how to use straight edges in order to make a flat surface, and how the inaccuracies in one flat surface can only be corrected by comparing or testing it with *two* others, they would have been giving the cadets valuable information.

The book hardly merits serious review. To tell a student that "a screw may be defined as a cylindrical bar on which has been formed a helical projection or thread," is giving an explanation which is harder to understand than the thing explained.

The book might, perhaps, somewhat coarsely, be described as mechanical hash—that is, it is a lot of fragments which have been thrown together without system and often, apparently, without purpose. The only features which can be commended are the printing and engraving. Both of these are excellent. Apparently the authors procured the services of a good mechanical draftsman, who supplied the illustrations. It is to be regretted that he did not write the book.

MAPS OF THE UNITED STATES GEOLOGICAL SURVEY. We have received from Mr. J. W. Powell, Director of the United States Geological Survey, 12 sheets of maps representing that part of the State of New York and a part of Connecticut adjacent to the Hudson River. These maps are drawn to a scale of 1-62.500, or a little more than an inch to a mile. They are approximately 17½ × 13 in. in size, so that each map represents an area of about 227½ square miles. The maps are drawn with the care and have the beauty which is characteristic of the work which comes from this department. The streams and other bodies of water are represented by blue lines, the topography by contour lines printed in brown or bronze-colored ink, and the roads, boundary lines, and lettering in black. They are exquisite examples of this kind of work, and what is of more importance, their correctness is authenticated by the United States Geological Survey and the State Engineer and Surveyor of New York. These maps are made by the co-operation of the Department at Washington and the State of New York, Congress and the State Legislature having each made an appropriation to meet the expense, and we are informed that the same thing has been done in the States of Connecticut and New Jersey.

Most of the sheets before us were engraved by the United States Geological Survey, one by Evans & Bartle, and the others by Julius Bien & Co., of New York. All the maps were made under the authority of the Director of the United States Geological Survey, J. W. Powell, Martin Schenck, Chief Engineer of the State of New York, Henry Gannett, Chief Topographer, H. M. Wilson, Geographer, in charge. The topography of different maps was by Frank Sutton, J. H. Jennings, G. L. Johnson, E. B. Clark, J. W. Thom, Robert Muldrow, R. D. Cummin, and W. M. Beaman. The triangulation was from the United States Coast and Geodetic Survey, New York State, and New York Aqueduct Commissioners' Surveys.

NEW ATLAS OF THE STATE OF NEW YORK. In connection with the previous notice it may not be out of place to mention that Messrs. Julius Bien & Co. have in contemplation the publication of an atlas of New York, which will fairly represent the greatest State in the Union, which, it may be added, no atlas yet published has ever done. We had the privilege of inspecting some of the advance sheets of this map, and think we are authorized in confirming the publishers' statement that it will be the most complete atlas of this State ever published.

It will contain a general map of the United States, showing State boundaries, principal cities and towns, river systems, railroads, etc. A general map of the State, showing county boundaries, railroads, canals, and all important cities and towns; also the new proposed State Park in the Adirondacks. A temperature map, showing mean annual temperature. A rainfall map, showing average annual rainfall. A population map, showing density of population. A hypsometric map, showing elevations. Also a large map showing original land grants, patents, and purchases throughout the State. These will be followed by detailed maps of each county on large scale, showing city and township boundaries, post-offices and villages, public roads, lakes, rivers, railroad lines and stations, with altitude where obtainable. The lot lines of the original land patents in the State will also be given (where obtainable), from the latest authentic data, most of which have never before been published. An alphabetical list of counties, townships, cities and villages, with population from last census, will be given, and all railroad stations, telegraph, express and post-offices will be appropriately designated.

"THE IRON FOUNDER" SUPPLEMENT. *A Complete Illustrated Exposition of the Art of Casting in Iron.* Comprising the Erection and Management of Cupolas, Reverberatory Furnaces, Blowers, Dams, Ladles, etc.; Mixing Cast Iron; Founding of Chilled Car-Wheels; Malleable Iron Castings; Foundry Equipments and Appliances; Gear Molding Machines; Molding Machines; Burning, Chilling, Softening, Annealing, Pouring and Feeding; Foundry Materials; Advanced Molding; Measurement of Castings; Wrought Iron, Steel, etc. Also the Founding of Stations; the Art of taking Casts; Pattern Molding; Useful Formulas and Tables. By Simpson Bolland, Practical Molder and Manager of Foundries. 7½ × 5 in., 392 pp. New York: John Wiley & Sons.

As indicated by its title, this book is a supplement to the author's earlier book, "The Iron Founder." The supplement begins with a chapter on the Evolution of the Iron Founder's Art, which is followed by one on Blast Blowers, which gives a description of the several kinds of blowing engines used in the past, as well as some of those in use at the present day. Among the latter the Sturtevant, the Mackenzie, and the Root blowers are illustrated and described. The chapter on Mixing Cast Iron, with the description of its chemical composition, it is feared, will not be of very material help to practical founders. Underlying the descriptions the author seems to entertain the idea that mixing iron is a great mystery, and the reader is left in doubt whether it has all been revealed to him. The chapter on Foundry Cupolas is very clear, but might have been fuller. A defect in the book is that no titles are printed with the engravings. In looking through a book of this kind, the "looker" often wants to know what a given illustration represents without reading the whole description of it. Titles to engravings are a great help in doing this. In these days of overmuch literature, the number of people who look through books and *don't* read them is much larger than those who *do* read them. The demands of the former class ought to be regarded. In the chapter on Reverberatory or Air Furnaces their characteristic features are not sufficiently explained. A little elucidation of the construction and operation of each would be a great help to students who are not practical founders.

The subjects treated are: Casting One Hundred Tons of Iron, showing the construction and use of the necessary equipment for pouring heavy castings, dams, receivers, air furnaces, ladles, with table of capacity, runners, etc.; Castings, how to obtain their measurement and secure their weights. In this latter chapter there is a long dissertation on arithmetic, men-

suration, tables of weights, and strength of different materials which ought not to have a place in the body of the book. If given at all, it ought to have been placed in an appendix.

A chapter on Foundry Appliances includes testing machines, block and plate methods of molding, gear molding by machinery, and a description of some modern molding machines. A reviewer cannot help but see what an excellent chance the author missed of giving a sort of primer on the strength of cast iron, how to test it, its behavior under test, and the influences which effect its strength. The engravings in this chapter, especially those of molding machines, are very bad, and the descriptions of them inadequate. Chains, Beams, Slings, Hooks, Ropes, etc., Pouring, Flowing-off, and Feeding Castings are described in much detail, and the reader will be richly repaid for the time given to this part of the book. In the remaining portion of it the following subjects are discussed: Studs, Chaplets and Anchors, High Class Molding, Sectional Molding for Heavy Green Sand Work, the Founding of Statues in Iron and Bronze. This last chapter contains an engraving of a statue of Venus which makes one doubt whether she was the goddess of beauty. If she resembled the engraving, she was certainly not a beautiful goddess.

The author gives us dissertations on the art of Taking Casts, Pattern Modeling in Clay, the Making of Malleable Iron Castings and Chilled Car-Wheels, directions how to Repair Broken and Cracked Castings, and ends with descriptions of the qualities of various materials used in foundry work and various useful receipts.

The book has the merits and the defects of literature which is produced by "practical" men. It is full of information relating to the difficulties encountered in doing foundry work, but in other directions, as has been indicated, the treatment of the subjects is inadequate. On the whole, it may be highly recommended to those who want information concerning the details of foundry practice. The printing and paper are only "fair to middling;" some of the engravings are excellent, others poor, and still others positively bad.

TRADE CATALOGUES.

VALENTINE & Co. have sent us a pocket memoranda tablet with calendar. It is bound in leather with celluloid covers, and is designed in the admirable style which characterizes all the advertising devices of this house.

THE LINK-BELT MACHINERY COMPANY have issued a little pocket edition of a pamphlet describing the Ewart Friction Clutches which they manufacture. It is well illustrated with good engravings and descriptions of the clutch.

UNITED STATES METALLIC PACKING COMPANY, of Philadelphia. 51 pp., 4¼ × 7 in. Illustrated. Describes different kinds of packing made by the Company, with good illustrations showing sectional views of it, and a long list—which occupies 40 pp.—of users of it.

THE BUCKEYE AUTOMATIC CAR COUPLER COMPANY, Columbus, O. 25 pp., 6 × 8¼ in. Illustrated. Describes coupler, shows dimensions and gauges, form and method of construction, gives specifications of tests, describes material used in manufacture, and gives reports and illustrations of results under Master Car-Builders' tests.

BOOKS RECEIVED.

Bureau of the American Republics. Bulletin No. 61, *Uruguay.* Washington, D. C.

Electricity up to Date, for Light, Power, and Traction. By John B. Verity, M. Inst. E.E. New York: Frederick Warne & Co.

Eleventh Annual Report of the Board of Railroad Commissioners of the State of New York for the Year 1893. Volume I. Albany.

Seventh Annual Report of the Interstate Commerce Commission: December 1, 1893. Washington: Government Printing Office.

The Electric Transmission of Intelligence and other Advanced Primers of Electricity. By Edwin J. Houston, A.M. New York: The W. J. Johnston Company, Limited.

The Cincinnati Southern Railway. A Study in Municipal Activity. By J. H. Hollander, Fellow in Economics, Johns Hopkins University. A memorial of Lucius S. Merriam, Ph.D. (J. H. U.). (Johns Hopkins University Studies in Historical and Political Science.) Baltimore: The Johns Hopkins Press.

The Correspondence School of Mechanics. A System of Home Study in Mechanics, Geometrical and Mechanical Drawing. This is a pamphlet of 56 pages describing the methods and course of instruction in this school, which is located in Scranton, Pa. Doubtless there are many students who are unable to go to a technical school and who will be glad to avail themselves of a course of study which they can pursue at home. The volume before us will give them information about the system adopted in the school which has issued this publication.

Fiber-Graphite Bushings for Hangers, Pillow-Blocks, Loose Pulleys, etc. Requiring no oil. The Link Belt Machinery Company, Chicago, Ill.

This little publication describes the merits of fiber-graphite, of which it is said "that by its use line shafting and journals of like kind may be run absolutely without the use of oil or other applied lubricant, at any desired speed and at pressures up to 50 lbs. to the square inch." Of such bearings the publishers say that "about 4,000 have been installed." Fiber-graphite is described as "simply the highest grade of lubricating plumbago, compounded with other materials in such a manner as to produce virtually solid graphite linings."

Many readers will probably read what is said in this publication with incredulity, but the Company issuing it are not given to making representations which they cannot substantiate.

AN EDITORIAL PERPLEXITY.

THE following letter, addressed to the editor of this paper, was received through the mail a short time ago:

DEAR SIRE

I am very interesting over this Problem in yours Book from the January. This Problem it is right when you all this Questions in a answer and in a Drawing you got Part I. What is the circle? Part II Whe you make a straight line in a round line and a round bak in a straight line Part III How many Diameter you got in the Elipse or oval? Part IV Whe you finishet the Diameter out from the Elipse or oval. Please Mr you will send my bak on answer I give you over all an answer and a drawing.

Yours very trully

— —.

The meaning of this is as hard to make out as the explanations in some of the recent technical books.

TENDER FRAME, PHILADELPHIA & READING RAILROAD.

To the Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

I notice in the December number of your JOURNAL an article on Philadelphia & Reading iron tender frame, which contains some errors which I would beg leave to correct. First, the channels are not butted together on the center line, as stated, but on the sides, 33½ in. from end. This is done for two reasons. The frame being but 90 in. wide makes the end sill or bent portion comparatively small, and therefore much easier and cheaper handled in smithshop than if side sills were bent at ends, as per your statement. All our old iron tenders had channels butted in center, but without proper bracing this became an element of weakness, and in repairing, instead of just putting in patches, we put in whole new ends and spliced same to sides with splice plates from 2 to 3 ft. from ends, as shown on engraving, and have had no trouble with this construction. We therefore adopted this in preference to the old construction on the new frame. This splice is also at a part of the frame which is not subjected to heavy transverse loads, as it is at or near the extremity of tank. In tension this splice possesses strength equal to other parts of frame.

The body bolster is composed of three pieces, the tension members being ¾ in. × 6 in., and the compression 1 in. × 15 in. The tension members being flanged at end are made in two pieces for convenience in smithshop. The compression

member, not requiring such difficult bending, is left in one piece.

You take us to task for the scanty diagonal bracing. I would beg leave to state that we have frames in service with bracing which is inferior to this, and we have no trouble. Furthermore, there is space allowed for a water scoop and necessary mechanism. If you examine into detail, you will also find that if bracing were extended it would be impossible to get it either in or out without tearing frame apart.

The old design of frames called for a number of holes through flanges of channels, and particularly was this the case where the bolsters crossed the sills. The consequence was that the sills would bend through these holes, for the very life of the metal was cut away. In the new design you will not find one hole in the flanges, except at such places where the channel is not subjected to an upward or downward thrust, or near the ends of the channels, where the strength is excessive.

When the channels are subjected to a load, you will invariably find the holes at or near the neutral axis of the beam. To accomplish this it became necessary to make some parts somewhat expensive. Notice the construction where the bolsters are fastened to center sills. The channels rest on projections from a cast-iron box or filling piece, to which they are bolted through the neutral axis. The bolsters are also bolted to this box, which extends ¼ in. above channels, thereby taking away all possibility of bolsters and channels chafing on each other and cutting away the best metal if they should become loose.

At the front end it was possible to get in only one stiffening plate ½ in. thick. At the back end there are two, one top and one bottom. The brackets for bumper-blocks are bolted direct to the under plate. The bracket for back pulling casting is also bolted to same plate. In addition to the stiffening plates at back end there is also a filling casting between plates and between center sills, to which casting the plates and sills are bolted, thereby making a solid construction at back end.

These plates, both back and front, take the anchor-bolts which hold tank in position. The floor (not shown on drawing) is bolted to strips which are on inside of center sills and on outside of side sills, but which are not bolted to sills. It would, therefore, be possible after raising tank to take floor off in one piece. We deem the weight of tank and strips sufficient to keep floor from shifting in all ordinary service, and in case of a wreck its construction does not matter much.

READING, PA. E. L. MOSER, M. E.

MODERN LOCOMOTIVES.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

The Midland Railway Company at Derby Works has just turned out a new express engine, No. 179, designed by Mr. S. W. Johnson, being the first of an order of 10 having several new features. Like the former engines of the class, it has a leading bogie and single driving-wheels of 7 ft. 6 in. diameter. The cylinders of the 179 class are 19 in. × 26 in., and inclined downward to the driving-axle. The valves are of the piston pattern worked by link-motion, and placed below the cylinders and inclined upward to the driving-axle. The boiler pressure is 160 lbs. per square inch.

No. 179 has been tried a few trips before being painted, and has given some wonderfully good results.

There seems every reason to believe that piston-valves placed under the cylinders will be a striking improvement, the very fact that they drain the cylinders of water is of the highest importance in practice. CLEMENT E. STRETTON, C.E.

LEICESTER, December 20, 1893.

THE INDUSTRIES OF CHEMNITZ.

To the Editor of THE AMERICAN ENGINEER AND RAILROAD JOURNAL:

Somebody was good enough to give me a marked copy of your very interesting magazine, THE AMERICAN ENGINEER AND RAILROAD JOURNAL. I read its contents, and cannot help complimenting you on style, stuff, and make-up. The articles, besides being well written, are nicely, neatly, and intelligently illustrated, the matter is of current interest, treated broadly enough for the layman, and detailedly enough for the technician; the magazine is a very convenient size, well printed and bound. I cannot comment on these things without complimenting their author. Merited praise is the hard worker's and just man's due. Intelligent men cannot be flattered. What I want to say here is that Chemnitz, this far inland Saxon city, the Manchester and Nottingham of Germany, illustrates as much as any city in the empire the striving, get-there spirit of the modern German.

In 1834—60 years ago—Chemnitz counted within her gates 21,137 people; to-day she has 150,000: 1834, 21,000; 1840, 23,500; 1846, 29,000; 1852, 34,000; 1858, 40,500; 1864, 55,000; 1871, 68,000; 1875, 78,000; 1880, 95,000; 1885, 110,000; 1890, 138,950; 1894, 150,000.

Chemnitz counts in the world's markets as Germany's textile center. Here is the home of hosiery and underwear. Last year (1892) there came into Chemnitz 13,668,951 lbs. of raw cotton, 9,231,439 lbs. of cotton yarn. There was sent out 1,612,778 lbs. raw cotton, 5,231,644 cotton yarn, and 16,056,962 cotton and woolen goods.

Back in the forties Chemnitz began the manufacture of machines. During the decade that went out with 1850 she could count only 833 persons in her machine shops. One concern alone until quite recently employed 5,000, and to-day, in spite of dull times, has on its active pay rolls 3,500. One Company, the Saxon Loom Company, has sent out its 50,000th loom, and employs (A.D. 1893) 1,000 persons. Last year there was brought into the city 35,022,847 lbs. of raw iron; there was sent out machines and parts of machines, 48,501,000 lbs.

The companies that counted themselves fortunate in 1851 with $1,000,000 worth of work turned off, ran up a record last year of $7,500,000. In 1851, $750,000 measured the amount in textiles; last year and for several years past it has been above $17,000,000.

To-day (A.D. December 20, 1893) started the narrow-gauge trolley electric cars. Last year the company carried in horse-cars 1,500,000 persons, pocketing $40,000. The local banks turned over $234,069,835, one bank alone doing a business of more than $28,084,000. How was it possible to do all this and the "much more" that goes with it, but not interesting enough to take up your valuable space? First of all, because of energy, activity, enterprise, and intelligently directed advertising. One firm jumped from 230 hands in 1885 to 736 in 1888, from thousands to millions. How? By going to a place or country called the United States of America, lying in latitudes between Mexico's Gulf and our great lakes, and between longitudes west and east running through Cape Cod and the Golden Gate, and not only telling the people about his wares, but by getting American papers—for pay, of course—to "push them." By combining chemistry with practical workmanship, by putting the theorist, the scientist side by side with his trained workmen to watch every change. He got the secrets wanted, worked them up, and conquered. It is a combination that gives Germany her successes. Her schools, especially her real gymnasiums, the technical, industrial, and industrial art schools are doing it.

In business schools *we* beat the world, but in building up captains of industry, the man to make science the handmaid of inventive genius, to rob Nature, where no necessity demands, of her richest secrets, Europe leads. France, Switzerland, Germany, Scandinavia, Russia are ahead.

Get these schools for us, give them to Yankee genius, and the end will more than justify effort and expenditure. Out of these cities are sent trained men year after year. They go by rail, boat, or caravan into remote and near countries, they carry their country with them, they come back bringing orders or send them. These orders, no matter how small or large, are filled. Colors that cannot be obtained elsewhere the German plods till they are obtained. He may not be brilliant as his French rival, or inventive as our Englishman, but, better than both, he knows how to take up, persevere, carry out and combine. To tireless energy he unites a plodding perseverance, sure in time to bring their rewards.

J. C. MONAGHAN,
Consul.

CHEMNITZ, December 21, 1893.

THE RAILWAY SIGNAL QUESTION.

Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

The increasing number of serious collisions between railway trains has for some time elicited unfavorable comment respecting the management of our railways. It has been pointed out that in nearly every case the signaling apparatus was wretchedly primitive, or else that no signaling was used. Now, in point of fact, the science and art of railway signaling have been developed to a remarkable extent during the last twenty years. The English railways, being those which earliest saw large and congested traffic conditions, with ever-increasing demand for greater speed, have naturally borne the

brunt of practical experience in the signal field, and consequently American railway managers have not so soon become aware of the importance of this branch of the service.

The recent disasters have to a certain extent awakened a few managers to the increasing ratio of danger in proportion to the ever-increasing number and speed of trains, but in all probability no very general introduction of proper signal appliances will take place until the Government is compelled to exercise some kind of supervision of railroads to guard against the recurrence of such cycles of disasters, which will surely come in future if some such precautions are not taken.

Collisions between railway trains may be divided into three classes—viz. : 1. Rear end, or those which are caused by one train overtaking another occupying the same pair of rails. 2. Butting, or those caused by mistaken understanding as regards right of way in single track working. 3. Those caused by the wrong placement of switches, or the confliction of signals at junctions or grade crossings. It is generally conceded that the best way to guard against rear-end collisions is by the adoption of the block system. The managers of some roads have apparently understood this to mean simply the division of track into block sections of suitable length, and the employment of men at the block stations in telegraphic communication with each other.

Discipline and the use of properly constructed block-signaling instruments, operated under carefully formulated rules and regulations, have played quite a third-rate part. The comparative efficiency of the block system installed in this way, instead of as experience would dictate, may be illustrated by troops armed with gas-pipes, instead of rifle barrels. It is necessary to provide two safeguards for the aid of the signalman in the performance of his duty—viz. : 1. A carefully constructed block signaling mechanism ; 2. A carefully prepared set of rules and regulations dealing with the numerous contingencies of traffic, for the governance of all concerned with the safety of the line.

The New York Central and the New York, New Haven & Hartford railroads have recently equiped the most important parts of their lines with signaling, which in general, but not in detail, may be said to represent the crystalized result of all technical experience since railways were commenced.

The mere equipment of a railway with good signaling appliances is, as aforesaid, only half the battle, and it yet remains for our best railways to formulate proper and sufficient rules and regulations suitable to the divers contingencies arising from time to time in the movement of trains.

It was with a glimpse of this need in view that the American Railway Association recently appointed a committee to investigate the block signaling at present in use in this country, and to draw up a set of standard rules. Their attention is drawn to the fact that a very good basis for their work may be found in the rules drawn up by the Railway Clearing House of Great Britain.

Where but one track exists, necessitating the use of the rails in both directions, a most serious condition faces us—viz., the danger of a butting collision, through mistake as to right of track. The safeguard at present in use in this country depends entirely upon the proper transmission and understanding of telegraphic messages, sent to the crews of those trains which are to pass each other at passing sidings other than those indicated by the time schedule.

It is needless to point out that mistakes often occur in this message system, resulting seriously in almost every case. This grave danger appears to have been at last overcome by the aid of mechanism, molded to form by railway men of experience.

The new safeguard is known as the Interlocking Train Staff System. Each section of single track between two passing sidings is provided with two staff machines, one at each end. These machines contain a number of metallic staffs, and are electrically interlocked through the medium of line wires. No train or engine is allowed to proceed on any piece of single track until the engineman has received a staff. The issue of a staff from the machine is under the electrical control of the signalman at the remote passing siding, and the issue of more than one staff from any pair of machines at one and the same time is mechanically prevented.

The issue of a second staff for another train proceeding in either direction is dependent upon the rehousing of the free staff in one of the machines appertaining to that section of single track. It will be clear that as only one train staff can be out, therefore only one train can occupy any section of single track at one and the same time. It may be pointed out that this is simply a form of block working. Staffs are employed instead of or in addition to the line signals, because the authority to proceed does not depend on sight, but is tangible, in the form of a staff. Experienced men consider this extra precaution very advisable, on account of the dangers peculiar to single-track operation.

This brings us to a consideration of the means employed to guard against collisions at junctions or other points where switches occur and trains are required to cross the path of others at various speeds.

The interlocking system is invariably employed in such cases. This system consists of the concentration at a central point of all the signal and switch-operating levers of any system of switches. These levers are so interlocked with each other, by means of mechanical appliances, as to make the setting of conflicting switches and signals mechanically impossible. In addition to this all the facing switches are provided with a device known as a detector bar, which prevents the signalman from throwing the switch under a train and thus causing what is known as a "split."

When the block system is in use these interlocking plants are necessarily combined with the block working, and in fact become the most important block stations. All switching operations on the main tracks are thus carried on strictly under the block rules.

A. H. JOHNSON.

THE LOCOMOTIVE PROBLEM.

(Correction relating to the last solution.)

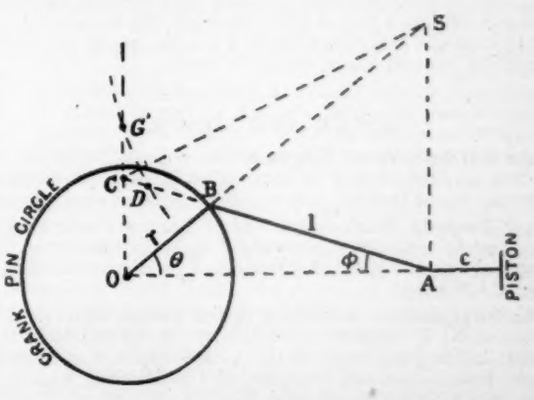
BY RENÉ DE SAUSSURE, C.E., ROANOKE, VA.

[THE following paper is proffered by Mr. de Saussure as a correction to the solution given in our January issue. As the subject has now been most fully treated, we deem it advisable to close the discussion with this publication.—ED.]

So many different solutions of this problem have been already published in the AMERICAN ENGINEER (and the problem having of course only *one* correct solution), it is high time to settle this question and to proclaim which one of the solutions is correct.

I attempted in the last issue (January, 1894) to give a purely geometrical solution, employing the usual methods of the cinematical geometry ; this demonstration is correct, but I must confess that the conclusion I made then was wrong ; in other words, it is true enough that if the connecting-rod $A\,B$ is produced until it meets at C the vertical line drawn through the center O, the speed of the piston is at any time proportional to the length $O\,C$, so that the maximum speed of the piston is attained when $O\,C$ is maximum. But I was not right in saying that $O\,C$ is evidently maximum when the connecting-rod is at right angle with the crank-pin radius, and I want to correct this part of the solution.

As the correct part of my last demonstration was purely geometrical, I propose to use only geometrical reasonments all the way through—that is, to find geometrically when the maximum of $O\,C$ occurs.



I have shown already that during an element of time, $d\,t$, the connecting-rod rotates around the virtual center S. If G' is the position of C after the time $d\,t$, and if we trace a circle passing through G', taking S as a center, this circle cuts the connecting-rod $A\,C$ at a certain point D, and D is the place where G' was before the element of time $d\,t$ had elapsed.

Reciprocally, if we knew the position of D we could obtain the next position of C by tracing a circle through D (S being the center) and taking its intersection with the vertical line $O\,C$. Now, when the angle $S\,C\,A$ is less than 90° (as shown

in the figure), the point G', thus obtained, will be above C; and when the angle $S\,C\,A$ is more than 90°, the point G' thus obtained will be below C.

But the maximum of $O\,C$ will be attained when the next position of C will be neither above nor below C (the maximum corresponding to a stationary position of C during the time $d\,t$). In order to fulfill this condition, the line $S\,C$ must be exactly at right angle with the connecting-rod $A\,C$.

The problem is now completely solved by a purely geometrical method, and I will announce it as follows:

"*The maximum and minimum speed of the piston happen for the two positions of the connecting-rod, in which this connecting-rod is at right angle with the virtual line S C.*" This is, I think, the first complete and correct geometrical solution of the problem.

This solution contradicts of course the one I published in the last issue, on account of the mistake made in the latter as above mentioned. I thought then that the maximum speed of the piston was attained when the connecting-rod was at right angle with the crank-pin radius; on the contrary, the connecting-rod must be at right angle with the line $S\,C$, and this condition prevents it to be also at right angle with the crank-pin radius $O\,B$, because $O\,B$ and $S\,C$ meet at point S, and therefore are not parallel.

I retract, then, all I have said concerning the prior analytical solution given by Mr. C. H. Lindenberger (in April, 1893), and apologize to him for having said that his solution was not right. On the contrary, the geometrical solution as given here confirms the result obtained by Mr. Lindenberger analytically, that the maximum speed of the piston does not correspond to the position where the connecting-rod is at right angle with the crank-pin radius, but is very near it (this is shown by the fact that when the connecting-rod is at right angle with $S\,C$, $S\,B$ is very near $S\,C$, the point S being very far).

I will say further that the solutions given prior to the one of Mr. Lindenberger are not correct; such is the case of the solutions given by W. H. Trethewey, Stratford, Ont. (July, 1892); Edward Walker, New York (August, 1892); Professor F. A. Weihe, Delaware College (January, 1893), and myself (January, 1894), who assumed that the piston has a maximum speed when the connecting-rod is at right angle with the crank-pin radius. I do not speak of the solutions assuming that this maximum occurs at the highest and lowest point of the crank-pin circle, as no scientific methods could lead to such a result.

Only two solutions published so far were correct, the one of Mr. Lindenberger and the one of T. B. Leeper, Lafayette College, Easton, Pa. (July, 1892). I must say I did not have time to go over the calculations of Mr. Leeper, but anyway his method is able to lead to a correct solution. But these two solutions are analytical, and require a pretty long demonstration; besides, they do not give any geometrical or analytical condition defining the position of the maximum in a general manner. They have to assume that the length of the connecting-rod and the radius of the crank-pin are given numerically, and so give only the solution for the case corresponding to these numerical data.

As I said above, the geometrical condition defining the maximum and minimum speeed of the piston is that the angle $S\,C\,A$ be a right angle, and this condition applies to any size of the connecting-rod and of the crank-pin radius.

NOTES AND NEWS.

New Battleships for England.—In a recent Admiralty report it is announced that 10 battleships, already provided for under the Naval Defense Act, will be completed early in 1894.

Fast Torpedo Boat.—At a trial of Yarrow's new torpedo boat *Havock*, made near Gravesend early in December, the marvelous average speed of 30 miles an hour was obtained on a run of 100 miles.

The First Balloon Ascension in the United States.—The Herkimer, N. Y., *Democrat* is authority for the statement that the first balloon ascension in the United States was made by Messrs. Rittenhouse and Hopkins, of Philadelphia, some time in the year 1783, about 110 years ago.

A 100-lb. Rail on the Consolidated Road.—It is reported from New Haven that the work of relaying the tracks of the New York, New Haven & Hartford Road with 100-lb. steel rails has been completed between that city and Springfield.

An Omission.—The photographs of the United States cruiser *New York*, which were illustrated by half-tone engravings in our last issue, were taken by William H. Rau, of 1,324 Chestnut Street, Philadelphia, Pa. Owing to an oversight credit for the same was neglected at the time of publication.

Aluminum for Gas-holders.—Experiments have been made by MM. Goutes and Sibillot with the view of adopting aluminum as the material for the gas-holders of dirigible balloons, instead of silk or other stuffs, and the results of their experiments have been satisfactory.

Aluminium in Place of Tin.—In an article in the *Revue Scientifique*, M. L. de Djeri claims that aluminium will soon replace tin for many purposes. For equal volumes the price of the two metals is not very different, and the alloys of aluminium with copper, etc., are superior to those of tin.

Ships for the Manchester Canal.—The ships which will hereafter be built for use on the Manchester Canal are to have telescopic masts. The lower masts are of hollow steel, and the topmasts will be of wood and lowered into the former when the ship passes bridges.

New Process of Rain-Making.—A new process of rain-making was recently brought before the Academie des Sciences, Paris, by M. Baudoin. His theory is that electricity maintains the water in the clouds in a state of small drops, and if the electricity be discharged the water will come down.

Irrigation of the Mojave Desert.—The great project of irrigating the Mojave Desert by means of a mammoth dam to be built at Victor Narrows, on the line of the Southern California Railroad, appears to be an assured fact. Documents for the formation of a company have been completed and signed.

Italian Petroleum.—Attention has recently been called to the finding of sources of petroleum in Italy at Emilia, in the province of Chieti. The light given by it is of a clear opal color; 50 to 60 per cent. of the burning oil and 40 per cent. of benzine are obtained from it.

Pocket Telephone.—The policemen at Newcastle, Eng., are said to have been equipped with pocket telephones with a foot or two of wire attached. By means of these instruments they can communicate with the fire brigade through the fire signal boxes without breaking the glass doors of the same.

Aluminum Bullets.—Some experiments have recently been made for the purpose of developing an aluminum bullet, to be used in place of lead in rifle cartridges. It is calculated that a soldier can carry about 200 rounds. In testing the penetrating properties, it is said that they have been found to be superior to lead.

Benzine Wagon.—A four-wheeled wagon whose motive power is supplied by a benzine engine has been satisfactorily tested in Germany. It is intended to carry passengers through city streets or country roads, and can be run at the rate of half a cent a mile. The wagon and engine can be made for $500. The speed is as high as 15 miles an hour.

A New Gun.—M. Turpin, who is well known as a discoverer of the explosive melinite, has invented a new gun which is said to be very effective. Four charges can be fired from it in 15 minutes. These charges contain 25,000 projectiles, which are scattered over an area of 236,808 sq. ft. at a distance of 11,483 ft.

Longest Railway Tangent in the World.—The longest reach of railway without a curve is claimed by travelers to be that of the new Argentine Pacific Railway, from Buenos Ayres to the foot of the Andes. For 211 miles it is without a curve, and has no cutting or embankment deeper than 2 or 3 ft.

A Castle in the Air.—A Belgian engineer, Tobyanski, has evolved a project for an aerial castle for the Antwerp Exhibition. It is to be, judging from the illustrations published, an immense composite balloon consisting of six parts, which are to be held captive at a height of 1,600 ft. It is to be reached by elevators, and to have a café, observatories, etc.

India's Telegraph Service.—The report has been published that a great advance has been made in duplex telegraphy by an invention of one of the members of the Indian telegraph staff. It is said that duplex messages were recently transmitted without repeaters for a distance of 2,100 miles from Calcutta to Madras. The wire used was of copper.

Photographing Projectiles in Transit.—Professor Fritch, of Berlin, has succeeded in photographing projectiles in transit. He exhibited at a recent lecture photographs showing the air waves caused by the missiles, which formed a legible record of the velocity with which they traveled. The apparatus is said to be the invention of a boy named Vernon, of Edinburgh, Scotland.

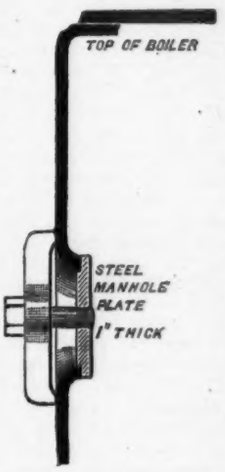
A New Insulating Material.—The great electrical manufacturing concern of Berlin has introduced a new insulating material which is intended to replace rubber and vulcanized

fiber. It can, it is claimed, be turned, filed, and drilled more easily than hard rubber; fine screw-threads can be cut on it, and it can be polished. It does not attack metals, and can be used in place of marble and slate for switchboards. It resists a temperature of 450° F., and is unattacked by hydrochloric or dilute sulphuric acid.

First Test of the Air-pump.—The first public test of the air-pump was made in 1654 by its inventor, Otto von Guericke, in the presence of Emperor Ferdinand of Germany. Guericke applied the carefully ground edges of two metallic hemispheres, 2 ft. in diameter, to each other. After exhausting the air by his apparatus he attached 15 horses to each hemisphere. In vain did they attempt to separate them because of the enormous pressure of the atmosphere. The experiment was a great success.

Hungarian Railway Tickets.—The railway marks invented by the Hungarian Minister Lukais will shortly be adopted on all Hungarian railways. For the future no traveler on Hungarian railways will be troubled to stand waiting at the ticket office for his ticket. He will be in a position to make out his ticket for himself. On a blank card he will write the name of the station from which he takes his departure, and that of the station he means to go to, and he will stick on to the remaining empty space on the card as many "railway marks" as his journey will cost. The blank cards will be obtainable at all tobacco shops.—*London Daily News.*

Hand-hole Cover for Boilers.—We illustrate a man- and hand-hole cover that has been designed by Mr. A. B. Willits, of the United States Navy, for marine boilers. The plate is flanged inward, the edge faced and a steel plate cover used inside, pulled up to the face by a bridge and bolt in the ordinary way. It is simpler and better than the old flat hole stiffened by a ring riveted on.—*The Engineer.*



HAND-HOLE COVER.

Disincrustation of Boilers with Liquid Carbonic Acid.—The *Revue de Chimie Industrielle* says that at a recent meeting of the Scientific Association of Saxony one of the members described the use of liquid carbonic acid as a boiler disincrustant. The boiler having been filled with cold water, carbonic acid was introduced from a receptacle near at hand. When the water was saturated with the gas, the acid dissolved the carbonate of lime, which was the principal element contained in the scale, and precipitated the gypsum which was combined with it, leaving the sheets of the boiler perfectly clean.

Experiments with Shingles.—An interesting experiment with shingles was tried a short time ago, says a writer in an English journal. A green 6-in. cedar shingle, fresh from the saw, was measured and weighed, care being taken to get both exact. It was found that it weighed 7 oz. It was then dried and again weighed and measured. It had shrunk nearly ¼ in., while the weight had decreased from 7 oz. to 3 oz. It was then submerged in water 24 hours, and the size had not changed a particle, while the weight had increased 1 oz., demonstrating the superiority of cedar shingles over others, as when once dry they will neither shrink with excessive heat nor pry one another off the roof in wet weather.

Hardness of Copper and Zinc.—An interesting fact concerning the relative hardness of copper and zinc has been brought to light by means of M. Paul Jannetaz's new sclerometer. Most authors regard zinc as harder than copper. If, however, the metals are examined in a sufficiently pure state, it appears that copper is the harder of the two. This removes an exception to the rule that the harder the body the less its atomic volume.

Tunnel and Bridge to Copenhagen.—Owing to the accumulations of ice which cuts off Copenhagen from the mainland during part of the winter, it is now proposed to build a tunnel between the island of Seeland and Funen and a bridge between Funen and the mainland. The construction will be easy owing to the soft nature of the bottom, and the island of Spragal will be used for ventilation and other purposes. When the work is completed it is estimated to cost about £1,800,000. Copenhagen will be two hours nearer the continent.

Comparison of Artificial Lights.—It is stated that a careful examination under the spectroscope of various lights shows that the arc lamp and the improved incandescent gas-lights are the artificial sources of light that approach sunlight most nearly in nature; but all artificial light has a warmer or more golden light than daylight. Ordinary gas flames and ordinary incandescent lamps emit the red and yellow rays, and are consequently less satisfactory. It is believed that a light closely approaching daylight in character could be obtained by the use of colored reflectors with arc lamps.

A Colossal Microscope.—According to the *Annales Techniques*, a gigantic microscope is being constructed in Munich. It has a magnifying power of 11,000 diameters, but this can be increased to 16,000 by means of an electric light, the image in this case being thrown on a screen. In order that the heat of the lamp may occasion no expansion of the metallic parts of the armature and consequently displace the focus of the lenses, a bronze cylinder containing liquid carbonic acid is so arranged that a little liquid escapes when the temperature reaches a certain point, and by its evaporation reduces the armature to a normal temperature.

Preservation of Wood.—M. Verrier has made an application of the following method of preserving wood. The wood which is to be injected is cut in the months of August and October, and immediately stripped of all the lateral branches, merely keeping a bouquet of leaves at the end of each limb. The wood is carefully cut or sawed so that all the pores of the wood which are exposed are immediately placed in vats filled three-quarters full of water, into which from 175 to 230 lbs. of pulverized sulphate of copper is added per 100 galls. The bouquet of leaves, left at the upper end of each limb, is sufficient to cause an ascension of the liquid by virtue of the capillary attraction, and the ascensional energy of the leaves.—*Moniteur Industriel.*

Cement for Steam-pipes.—A cement of specially valuable properties for steam-pipes, in filling up small leaks, such as a blow-hole in a casting, without the necessity of removing the injured piece, has been compounded. The cement in question is composed of 5 lbs. of Paris white, 5 lbs. yellow ochre, 10 lbs. litharge, 5 lbs. red lead, and 4 lbs. black oxide manganese, these various materials being mixed with great thoroughness, a small quantity of asbestos and boiled oil being afterward added. The composition, as thus prepared, will set hard in from two to five hours, and possesses the advantage of not being subject to expansion and contraction to such an extent as to cause leakage afterward, and its efficiency in places difficult of access is of special importance.—*American Gaslight Journal.*

Smokeless Powder.—The adoption of smokeless powder in the Italian Army is likely to cost Italy dear. According to the *France Militaire*, the smokeless powder used by the Italian artillery has irreparably damaged a very large number of guns. The powder has produced such an effect upon the bores of the guns, that some 500 have already been condemned, and orders have been issued to considerably reduce the amount of gun practice. Enormous expense will, in consequence, be necessary to restore the Italian field artillery to its former state of efficiency, no less a sum than £8,000,000 being mentioned as the amount required. If the report as to guns being rendered practically useless through smokeless powder being used be correct, it will probably have an important effect on the development of these powders, which have received such a stimulus of late years.

Ventilation of Sewers.—The municipal authorities of an English town have accepted the offer of a local lighting company to provide electromotors for ventilating the up-take columns of sewers. The motors are to be continuously supplied with current for three months for $25 each, tests being taken in the mean time on the amount of foul air extracted from this sewer. The introduction of electromotors for this purpose is by no means the first occasion on which mechanical power has been employed for removing dangerous gases. Large blowers and fans have been successfully used for carrying a supply of fresh air through the workings at mines and collieries. Formerly the ventilation was effected by hot-air currents, a furnace being kept up in the up-take for the purpose of heating the outgoing air, and thus creating a draft.

A Type of Condenser.—An unusual type of condenser for use with steam engines is described in an English technical journal. It is built like an ordinary steam radiator except that it is much larger, the vertical pipes being slightly over 4 in. outside diameter. The exhaust steam from the engine enters one end of the coil of pipe, is condensed in its passage and is then pumped out of the other end by the air pump. A shal-

low trough extends along the top of the radiator, and is kept filled with water by a circulating pump; this water trickles down through fine holes in the bottom of the trough over the surface of the pipe, and keeps it cooled so that the steam within is condensed. The apparatus is placed on the roof of a shop, and has been working successfully for two years. Its advantage lies in the very small amount of condensing water required, which is only one pound per pound of steam.

Non-shrinking Timber.—The *Indian Textile Journal* is responsible for the statement that a timber known as "Billian," which grows plentifully in Borneo, is unaffected by water as far as dimensions are concerned, either when absorbing it or losing it by evaporation. It weighs 60 lbs. per cubic foot and it has a breaking strain 1.52 times that of English oak, while its weight is only 5 per cent greater. Compared with Burmese teak it is 62 per cent. stronger transversely, and 11 per cent. heavier. Billian or Borneo iron-wood is a hard, durable wood of a dark brown color. When seasoned it turns a deep red, and with long exposure becomes black as ebony. It resists the teredo navalis (so destructive among timber in salt water), and the white ant, and is almost indestructible. Its breaking strain is the highest of any known wood, and it is extensively used as sleepers, beams, piles and for any construction requiring strength and durability.

Petroleum and Coal Tar.—Petroleum and coal tar are frequently recommended and used to render posts durable, but their value varies with conditions. Coal tar applied hot may be made to form an impervious casing, shutting out air and moisture, but, of course, not preventing it from entering above. Bottled up in this manner it may promote decay. With different conditions it may prove a useful application, says *Country Gentleman*. With shingles it acts differently, being wholly exposed to the rain and air. Apply the petroleum by dipping the shingles in it in a tub of the oil, and allow a few hours for it to soak thoroughly into the pores of the wood, and then lay them in the usual way. It may be applied less perfectly to the shingles after they are laid, using a coarse brush for the purpose, and it should be renewed once in seven or eight years. It affects the rain-water only for a few weeks. In applying it to the roof crowd the points of the brush into the crevices between the shingles.

Utilization of Coal Dust in London, England.—The London *Times* gives an account of a process by which anthracite coal bricks are now being manufactured by the London Coal Brick Syndicate. The bricks are made of grains of anthracite dust, which are forced to cohere by means of a special cementing compound and by great pressure. The coal dust is mixed with the binding material in the proportion of 95 per cent. of the former to 4 per cent. of the latter. The compound is fed into a mixer, where it meets a jet of steam, a stiff paste being formed, which is delivered successively into a series of moulds under a pressure of 25 cwt. As the mould plate revolves the charge in each mould is brought between two rams, which exert a pressure of 2 tons per square inch on each side of the charge, forming a very dense and homogeneous coal brick. The brick, still in the mould, passes on to the delivery ram, by it is pushed out on to a table, and is removed for the market. These coal bricks are said to make an excellent fuel, and to possess a very high efficiency for steam-raising purposes. The *Times* thinks that with such a fuel at the disposal of the public there is room to hope for a reduction in the pollution of the atmosphere of towns.

Counterweight for Electric Cars.—Quite an ingenious method has been resorted to for assisting electric cars up a steep grade in Seattle. Two counterweights, aggregating 6 tons, run on a track in a conduit 3 ft. wide and 15 in. below the street surface, and at the bottom these weights abut against an air cushion made of two 8-in. wrought-iron pipes of 8 ft. length, inclosing 7-in. pistons of about the same length. At the other end of a steel cable attached to the counterweights is a small dummy running in a conduit 4 in. wide by 8 in. deep, placed above the larger conduit; this dummy has a bar hinged to it and projecting 8 in. above the ground, to which the draw-bar of the car is coupled. In operation, the loaded car descending the grade draws up the counterweight, which very nearly equals the weight of the empty car, the electric power and brakes being operated as on the level. In ascending, the counterweight comes down and pulls up the car, with the assistance of the electric motor to handle the load; when the car is uncoupled at the foot of the grade, an automatic catch holds the dummy in position for the next ascending car. Another simple but essential mechanism in carrying out this arrangement is the employment of a safety catch with the weights in case of breakage of the rope, and the coupling is automatic.

Basic Slag as Manure.—The slag resulting from the Bessemer basic process has been proved to possess valuable qualities as a manure, owing to the large percentage of phosphorus which it contains. As a tetra-basic phosphate of lime, in which form the element is present, it can be readily assimilated by plants, provided the slag is ground sufficiently fine. At the North-Eastern Steel Works a large milling plant has been erected, in which the whole of the slag, amounting to 25 per cent. of the total weight of steel produced, is ground by edge-runners or other means until about 83 per cent. will pass through a sieve of 120 wires per linear inch. It has been found by experiment that the efficiency of the manure is not increased by grinding it finer than this. Any small fragments of steel which may have become mixed with the slag are removed by magnets. The manure contains from 17 to 20 per cent. of phosphoric acid, 50 per cent. of lime, and 14 per cent. of iron oxides, together with smaller quantities of other ingredients. Exhaustive experiments have been made with the manure in this and other countries. It has been found most effective when mixed with other nitrogenous manures in the proportion of 4 to 1, and when 5 cwt. of the mixture is used per acre. It is then about equal to superphosphate in beneficial effect. At the price of 27*s.* per ton it commands a ready sale.

Gold Mining from a River-bed.—Gold is sprinkled throughout the Snake River country through Idaho, and there are numerous bars along the river that would prove profitable could water be commanded for sluicing or hydraulic work. To overcome this lack of water, as well as to insure sufficient dumping grounds, a big floating gold-saving barge has been constructed and is now at work on the Idaho bank of the Snake River about 10 miles above Pavette. It is a stern-wheel flatboat propelled by steam. Substantially constructed, 65 ft. long and 22 ft. wide, it is equipped with a 35-H.P. engine and boiler. With a slight alteration it could be transformed into a steam dredge and used to scoop sand and gravel from the bottom of the stream. That has never been attempted. As in the past, operations are now confined to working bars out of the bed or channel of the river. The method pursued is to anchor alongside one of these gravel deposits and by the use of scrapers bring the material to be handled within the reach of the gold-washing machinery with which the craft is rigged. The gravel is scooped up by buckets attached to an endless chain. There are 48 of these receptacles on a belt 60 ft. in length, and each has a capacity of about 20 lbs. of dirt, which is delivered into a hopper. This is also an agitator, and the process employed may be described as a steam rocker, with the exception that it has an end motion instead of one sidewise. The gold is caught on copper plates with quicksilver. The tailings are carried off in sluice boxes by the force of a stream of water of 150 mineral inches, supplied by a China pump, run by the engine that drives all the other machinery. The gravel is worked so thoroughly that no gold escapes in the river. An average of 100 tons of gravel are daily handled, and for this work three men are employed—an engineer, one to work the scraper, and another one who shovels the dirt into a pile so that the buckets can scoop up a full load.

An Improvement in Furnace Boilers.—At the fall meeting of the Alabama Industrial and Scientific Society held in Birmingham, November 24, Mr. Murray, Superintendent of the Linn Iron Works, described an improvement which he had been able to make in furnace boilers, whereby the use of a double-decked boiler with cylindrical mud-drum suspended beneath and a modification of the Spearman-Kennedy gas burner had resulted in notable economy.

Mr. Murray was obliged to dismantle a battery of boilers at the Alice furnaces consisting of two 46-in. in diameter return-flue boilers 34 ft. long. As these boilers did not give enough steam and the new boilers had to be put in the same space as occupied by the old ones, the problem had to be solved to secure greatest heating surface in a limited space. The new boilers were built larger in diameter and plain cylindrical heaters were added under each boiler. This new battery consists of two 54-in. return-flue boilers 34 ft. long, each having two 10-in. flues. Under and connected with each boiler is a plain cylindrical heater 36-in. in diameter, 31 ft. 2 in. long. These heaters start 8 ft. from the front, giving room for the grate and the bridge-wall. The heaters pass through the back wall 2½ ft. and a 20-in. mud-drum is suspended under the same on the outside of the brickwork. The same setting, hangings, and about the same brickwork were used as in the old battery. The new double-deck boilers give 1,660 sq. ft. of heating surface as against 1,040 sq. ft. in the old style, a gain of 61 per cent. The supplementary heaters afford 59 per cent. real gain. The increase of cost over the old system is only about 12 per cent.

Still better results were attained by introducing a separate jet of gas under the heaters in addition to the one under the boilers. For this purpose Mr. Murray designed a new duplex gas burner. The upper burner is the ordinary Spearman-Kennedy burner, the lower burner is connected with the base of the upper one through a 9 × 9-in. cast-iron pipe leading to a nozzle 24 in. × 3 in. Air for combustion is admitted on either side of the battery through the hot walls and envelops the gas-jet at its orifice from all sides. The results with this burner were very flattering, and the same is now used by several of the furnace plants in that district.

Accles Machine Gun.—The Driggs Ordnance Company, of Washington, have brought out a new machine gun invented by J. G. Accles. In a general way this gun resembles the Gatling gun, but has a number of important features. By a simple clutch at the side the firing mechanism can be thrown in or out of gear instantaneously, and, secondly, the gunner can easily throw a continuous stream of bullets, or fire shots singly—at the rate of about 400 shots per minute—the crank being turned at a steady rate all the time. The gun may be mounted on field-carriages, parapets, embrasures, and on all types of naval mountings. On board ships the guns are arranged so as to be actuated both by hand and by electricity. In using electricity the main current from the ship's dynamo is led to a smaller motor connected with the shaft which works the gun. Great rapidity of fire is obtained with this latter arrangement, 1,000 shots per minute having been fired accurately in recent experiments.

The gun fires only one shot at a time, and a cartridge cannot be discharged without the trigger being pulled. Turning the crank cannot, therefore, by any possibility, discharge cartridges unless the trigger is also pulled. The force of discharge is absorbed by the weight of the gun, so that there is no recoil or disarrangement of the aim caused by firing. While the habitual position of the crank is on the trunnion, a preferable location in the 10-barreled gun for accurate firing, it can be placed at the rear of the gun, making it possible to discharge all of the shots at each turn of the crank, or 30 shots a second, which is at the rate of 1,800 shots per minute. For the purpose of extreme rapid firing an arrangement is perfected by which the trigger can be locked in a position of permanent "pull," and rapidly turning the crank a constant stream of cartridges can be discharged. Placing the crank on the trunnion is thought by ordnance experts to be of great advantage, it being possible by having it in that position for one man to aim and fire the gun, as it is only necessary for the man to sit close to the breech of the gun to enable him to manipulate the crank attached to the right-hand trunnion. By this arrangement one man could load, aim, and fire the gun at the rate of about 600 shots a minute. It is thought that in action batteries may often be reduced to one man, and the possibilities in this respect are therefore of much practical value.

Novel Method of Track Shifting.—In the course of the four-tracking and other improvements on the New York, New Haven & Hartford Railroad between Woodlawn and New Haven, it has been sought to reduce the grades and to improve the alignment by reducing the curvature to 2°. At two places on the line there has recently been accomplished the shifting of long sections of track to embankments on the new grade without interruption of the regular traffic and at a low cost. Near Milford, Conn., there was a change of track extending 8,000 ft., with an average raise of 6 ft. and a maximum of 9 ft. The filling for third and fourth tracks had been brought to the new grade. Under former plans the two existing tracks would have been raised by a succession of such lifts as could have been properly tamped to permit of the safe passage of trains. The old tracks were, however, moved bodily on skids from the old to the new grade, making the new third and fourth tracks, and the old part of the railroad is then raised without interference from trains. The proposal to raise and slide the tracks on skids, with block and tackle, was so generally condemned by experienced trackmen that the roadmasters of the New York Division did not decide upon this step until an experimental strip had been removed by this means. The track was disconnected in five-rail lengths (150-ft. sections), and the skids, on which the sections were moved, consisted of rails spiked to 6 × 8-in. spruce timber, with dowels at each end, to which were attached the blocks and tackles. The work of shifting 8,900 ft. of track a distance ranging from 20 to 30 ft. and lifting it an average of 6 ft., was accomplished with 261 days' work, including the time of going to the work and returning, or, reckoning only the time actually spent in labor, a little more than 100 full days' work sufficed to place the track in position for surfacing. This stated to be about equivalent to that which under the usual methods would be necessary to draw the spikes, disconnect the rails, and to carry the ties and rails 25 ft., including the lift of 6 ft., after which it would be necessary to space and line the ties and to connect, gauge, and spike the rails. Four miles of track have been raised in this manner, including a stretch near Pelhamville, where the lift was 8 ft. and the lateral movement 35 ft. Experienced workmen brought the cost of this shifting down to 16 cents a lineal foot. The work was planned by C. C. Elwell, M., AM., Soc. C. E. Roadmaster of the division.

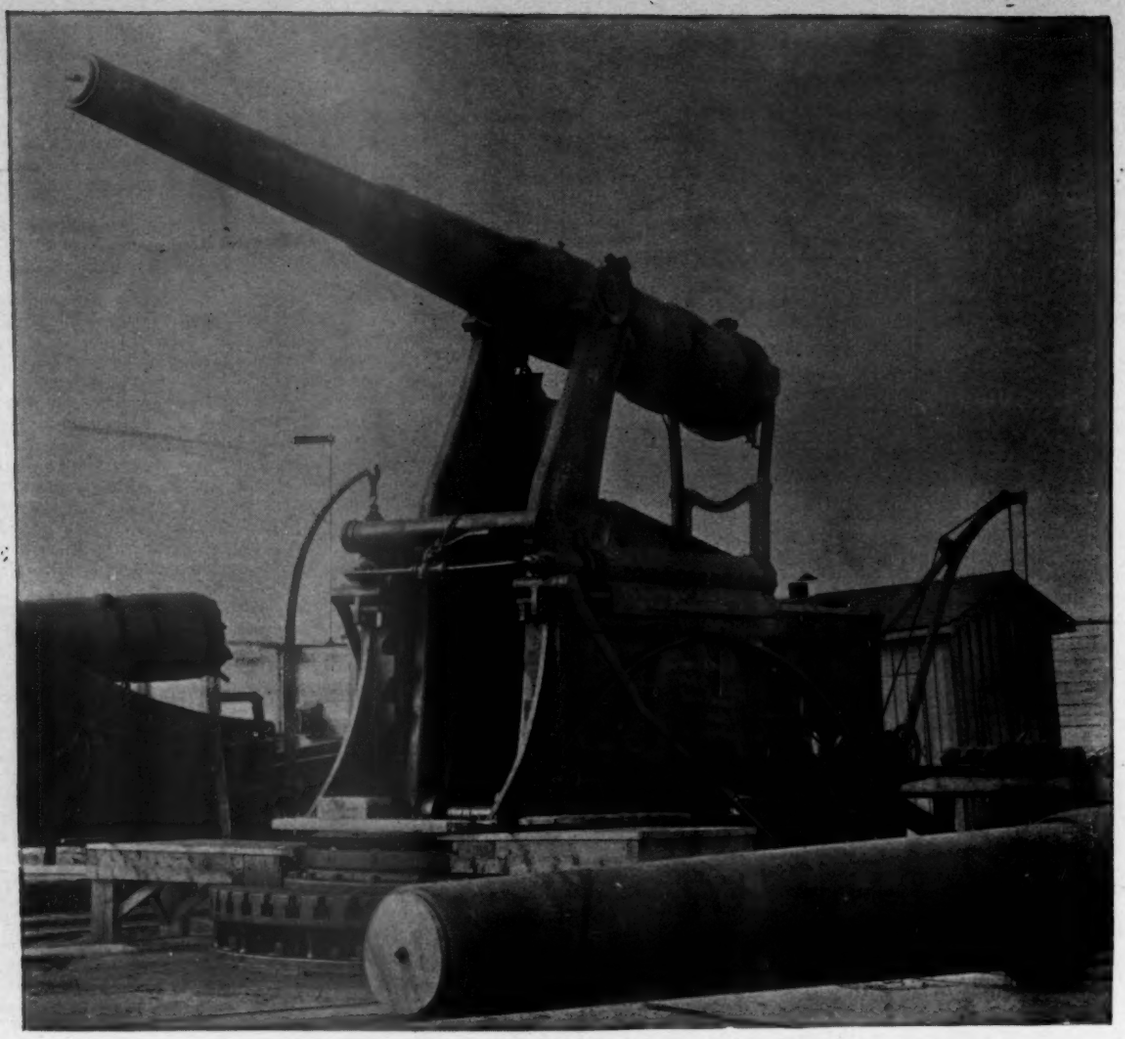
Travel on the Congo Road.—The Congo Railroad has arrived at the dignity of a time-table and schedules of passenger and freight traffic. What the road lacks in length it makes up in charges. It costs anybody who has a social position to maintain $10 to travel 25 miles. This is the first-class rate, and the drop from first to second class is precipitous and abysmal. The only accommodations for second-class passengers are such as they can find in the freight cars, but they can afford to stand up if need be, for they are required to disburse only $1 for transportation that costs the unfortunate few 10 times as much. Modern improvements in train management are a feature of the new African railroad. The fact that only one train a day starts from each terminus reduces to a minimum the danger of a rear-end collision; but as the Congo Railroad differs from our trunk lines in having only a single track, it is not expedient for trains to attempt to pass one another between stations. The four stopping-places along the line have therefore been connected by telephone, and conductors are under orders not to leave one station until assured by telephone that they will have a full monopoly of the track to the station ahead.

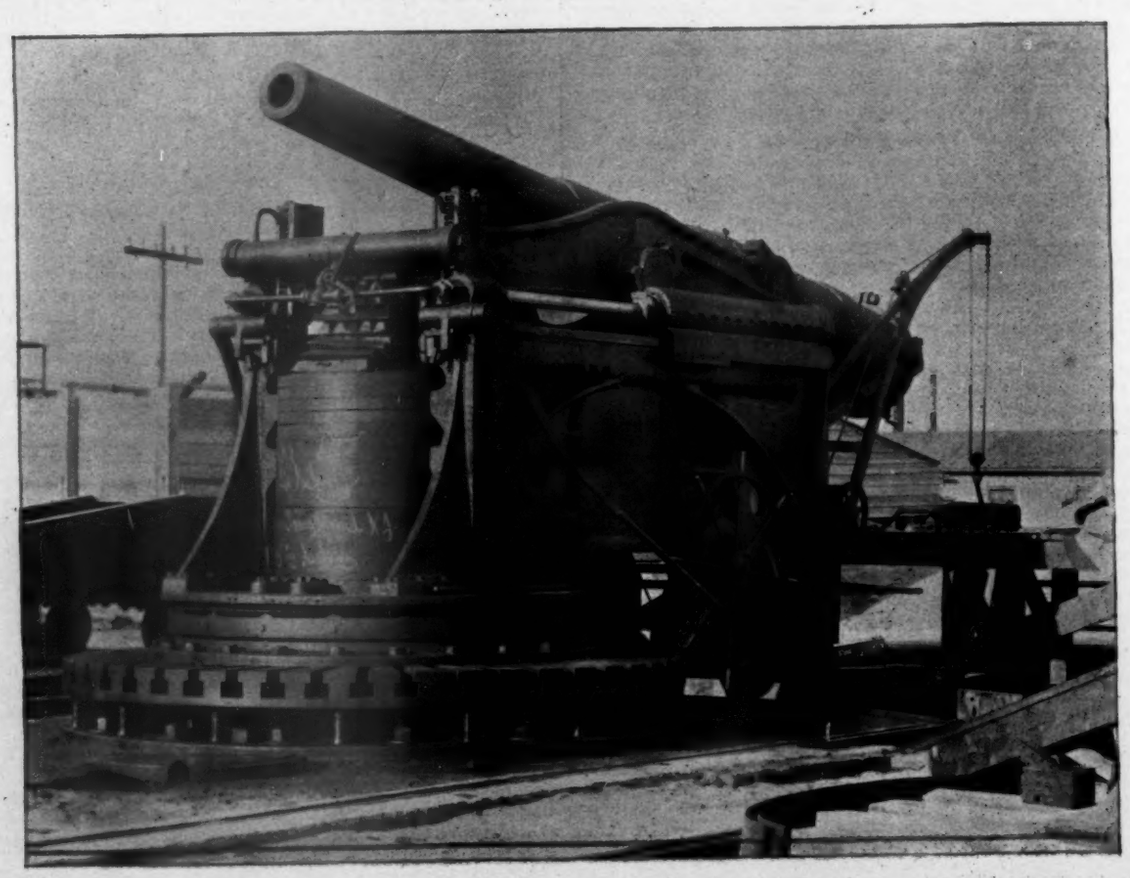
When the line is completed to Stanley Pool there will be a fine opportunity for tourists of the adventuresome sort to catch a glimpse of the lower Congo Valley and return to the sea breezes in a few days. It is to be expected that the progress of civilization will have a tendency to reduce the price of first-class tickets. The company, however, has a monopoly of railroad building for many years to come, and will be likely to charge all the traffic will bear, without any fear that competitive routes or ticket scalpers will demoralize rates. Of course, the needs of commerce and the pressure that the Congo Free State may exert will soon have a tendency to place all charges on a reasonable basis. The road is completed to Nkenge, 25 miles from its starting-point at Matadi. It is now fairly on the plateau behind the hills that overlook the foaming cataracts of the river. The road thus far has been hewn out of the toughest of rock, skirting first the Congo and then zigzagging up the Mposi River Valley, where a number of costly bridges were thrown over the troublesome stream. Nearly all the difficulties of the entire route have now been conquered and rapid progress may be made to Stanley Pool, where steamers from far and near will bring freight to the cars. Facts are stubborn things, and this railroad must astonish the small army of writers who affirmed a few years ago that white men could accomplish nothing in the trying climate of the Congo Valley.—*New York Sun.*

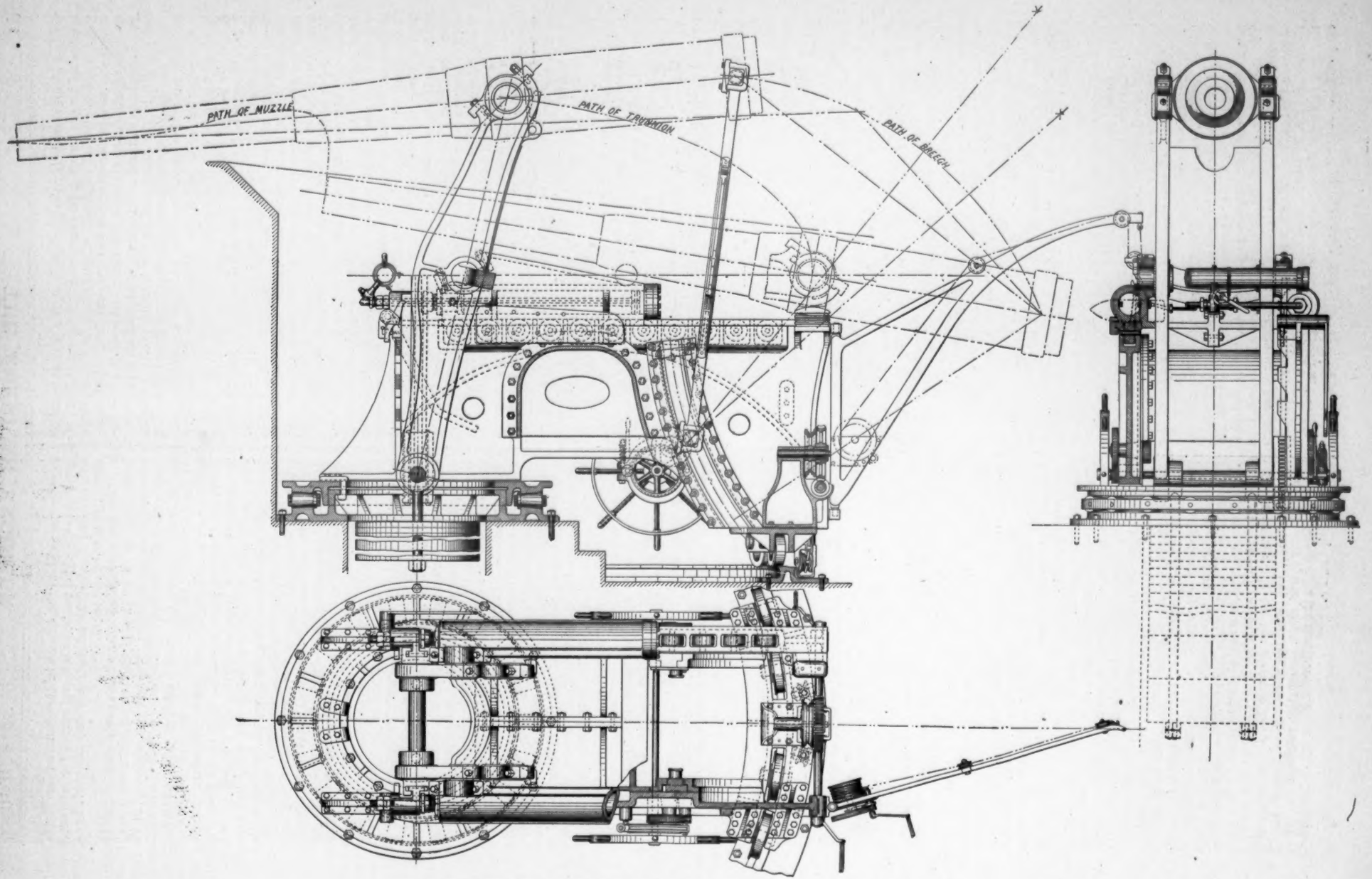
THE BUFFINGTON-CROZIER DISAPPEARING GUN CARRIAGE.

IMMEDIATELY after the adoption of a policy on the part of the United States Government to increase the naval and coast armament of the country, the Ordnance officers came to the conclusion that for an efficient coast defense a disappearing gun carriage was an absolute necessity. This stimulated a number of inventors, and several types of disappearing gun carriages have been evolved which are more or less successful, some of which have been constructed under orders from the Government and have been tried under the supervision of the Ordnance Department.

Among the earliest attempts at the designing of such a carriage was that of Colonel Buffington, a modified form of whose carriage was tested at the Sandy Hook Proving Grounds on December 14, a memorandum of which was given in our January issue. The carriage is known as the Buffington-Crozier carriage. Captain William Crozier, whose name appears in connection with the carriage, was detailed by the Government a number of years ago to visit Europe and gather such information as would be placed at his disposal, in regard to the condition of the art in the several military countries, and report the same to this Government. He found no disappearing carriage which, in his judgment, would warrant the appropriation of large sums of money by this country for construction. He brought home one or two gun carriages, of Russian and French design, of the non-disappearing type, but on further investigation in this country he came to the conclusion that the principle underlying the construction of the Buffington carriage was one which could be developed into great efficiency, and he there-







THE BUFFINGTON-CROZIER DISAPPEARING GUN-CARRIAGE WITH 8-INCH GUN.

fore set about remodeling the carriage in such a way as to make it suitable for the heavy guns intended for the coast defense of the United States. The result of his labors is the carriage which was used in mounting the 8-in. gun at Sandy Hook, illustrations of which are given in this issue. We show three engravings of the carriage: two taken from photographs showing the gun in the firing and in the loading position respectively, and also a reproduction of a working drawing of the carriage, for which we are indebted to Captain Crozier.

The principle upon which the carriage works is that there is a heavy counterweight so adjusted that when it is released it will, by falling, raise the gun to the firing position. Upon firing, the recoil of the gun throws it back to the loading position, at the same time raising the weight so that it is all ready, upon a second release, to fall to the firing position. An examination of the photographs and the line engravings shows that the gun is supported at two points—the trunnions and breech—by levers which stand nearly upright when the gun is in the firing position. On either side of the gun there is a hydraulic cylinder which moves back and forth over a rigidly fastened piston. On this cylinder the levers, which carry the trunnions of the gun, are pivoted near their center point. At the other end of these levers from the trunnions the counterweight is attached. The counterweights are so held that in rising and falling their motion must be truly vertical; cross-heads attached to them, running in guides in the main castings of the carriage. The cylinders, on the other hand, in their motion to and fro run over the guides which are at right angles to the guides carrying the counterweights. It is, therefore, evident, from the well-known law which has been so often applied in the construction of ellipsographs, that when one end and the center of a lever are moving at right angles to one another, the further extremity of the lever, which in this case carries the trunnions of the gun, must move through an arc of an ellipse. Therefore, in the recoil of the gun, the trunnions move back from the firing to the loading position through the arc of a perfect ellipse. On the other hand, the levers which are used for supporting the breech of the gun are pivoted to blocks held in the body of the carriage, so that as the breech rises and falls it passes through the arc of a circle. When the combination of these two motions is carried forward to the muzzle of the gun it produces a very unique motion, and one which could not be excelled in the retiring of the muzzle to the loading position at a point back of the parapet. It is as though one should take the muzzle in the hand, push it back to the edge of the parapet, and then suddenly lower it behind it. The principle on which the gun is worked is therefore very simple, and one which will readily be comprehended from the description and the mechanism when coupled with an examination of the drawing.

The gun is aimed while it is in the loading position. It is aimed by means of a range finder whereby the angle of firing elevation is obtained, so that the gun is not exposed to the enemy's fire except for the time required to rise over the parapet and retire; the time of pulling the lanyard being almost inconceivably short. The method of aiming is exceedingly simple. The horizontal aiming is of course obtained by swinging the carriage to the proper point. The vertical elevation of the gun is very easily and quickly obtained, inasmuch as the gun is not moved while aiming. The levers which carry the breech are pivoted at their lower extremities in a block which is similar to the link block of a steam-engine using the Stephenson link for its valve motion. This block slides between a pair of guides which are curved to a radius equal to the length of the lever, and with their center at the center of the breech trunnion when the gun is in the loading position. The gun is, therefore, down on its bed and there is no strain whatever on these levers, and the lower end can be raised or lowered by a suitable mechanism of gears and worms without any very great effort, by one man. But the mechanism is self-locking, so that the moment the block reaches a point indicated on the guides as giving the suitable elevation, which has been obtained by means of a range finder, the gun is ready for being raised to the firing position, and the elevation is obtained by raising or lowering the height of this movable block at the lower end of the breech levers. The raising of the block decreases the elevation of the gun, and lowering the block increases the same. The extreme elevation possible with the carriage given is 15° of elevation and 5° of depression. When the gun is back of the parapet an angle of 7° depression from the edge of the parapet just clears the top of the gun. The counterweight of the gun, as we have said, moves in a vertical line. It falls freely. When it rises and the gun settles to the loading position, a rack on the face of the cross-heads is caught by pawls attached to the carriage, and when the gun is finally down the counterweight is held in its highest position. A crane attached to the rear of the carriage serves to raise the shell to the breech of the gun and facilitates loading, but as this need not be an integral part of the carriage, it can be arranged to suit the convenience and taste of the officers having charge of the work.

After the gun is loaded and the lower end of the breech-lever fixed so as to give it the proper elevation when it has reached the firing position, two men are stationed at the forward end of the carriage with levers projecting through loops and bearing against the pawls holding the counterweights. At the command "Heave," they throw their weights against these levers and disengage the pawls, afterward drawing the levers out of their sockets and laying them on the ground behind the parapet. The counterweight thus released immediately raises the gun to the firing position. In doing this the cylinders on the side of the carriage are drawn forward, so that the pistons are down to the bottoms of the same. These cylinders are, as we have said, intended for taking up a portion of the recoil. The resistance of the recoil is taken up one-third by lifting the counterweight and one-third by each of the two cylinders. These cylinders are arranged on the same plan as the ordinary type of hydraulic resistance cylinders, such as the Fletcher recoil used on the Driggs-Schroeder gun described in our January issue. It consists of an hydraulic cylinder filled with liquid having an internally projecting lug, which is approximately wedge-shaped on the inner side. The piston is cut out to allow for passage over this wedge. At the back end of the cylinder where the piston is located at the moment of firing, the opening between the wedge and the piston is the greatest, because the motion there is the fastest. This clearance decreases toward the other end of the cylinder, and calculations are made in this particular instance so that the actual resistance to the recoil of the gun runs constant throughout the whole recoil. The liquid completely filling the cylinder simply flows from one face of the piston over the other, and it is this resistance to the flow of the liquid which takes up the force of the recoil. We have now seen that at the moment the command "Heave" is given, the counterweights fall, raising the gun to the firing position and drawing the cylinders to the front side of the carriage.

When the gun is fired the reverse simply takes place. The gun is thrown back to the loading position, the cylinder forced to the back side of the carriage, and the counterweight raised until it is caught by the pawls and held.

The rapidity of the action of this carriage is shown by the tests which were held at Sandy Hook, and to which we have already referred, in which 10 shots were fired in 12 minutes and 3 seconds. The party who visited Sandy Hook to witness these tests being unaccustomed to the noise of the firing of large guns, was cautioned to take refuge behind something in order that the sounds might be broken and no injury done to their ears. The writer of this was, during the first three shots, behind a building and about 5 ft. from the corner. Immediately upon hearing the report he jumped forward, but before the corner could be reached, which, as we have said, was only 5 ft. distant, the gun was back in the loading position, showing the rapidity with which the work was accomplished. Afterward from another position the whole firing was witnessed, and the ease and grace with which the gun settled back was certainly very remarkable. While no actual time was taken as to that occupied by the recoil and the raising to the firing position, it was variously estimated that from three to five seconds from the time the word "Heave" was given until the gun was back in the loading position, the remainder of the time was occupied in loading. Thus it will be seen that, making the most liberal allowance of time given by any one present, the actual time in which the gun was exposed to the fire of the enemy for each shot probably did not exceed two and one-half seconds, and in the opinion of the writer was somewhat less than this. In firing there is no apparent jar or shock thrown upon any portion of the carriage. Everything works smoothly and easily, and it is difficult to realize that such tremendous energies are at work. The shots which were fired at the time of the trial in December weighed about 300 lbs., and were fired with charges of 125 lbs. of powder each. Aside from its interest to Ordnance officers as an important element in our system of coast defense, this carriage offers us one of the finest examples of close calculations in machine construction and the capabilities of American workmanship of which we have any knowledge.

The body of the carriage is constructed entirely of steel castings, some of which were at the time of their casting the heaviest that had up to then been made in this country, and which were made by the Midvale Steel Company, of Philadelphia, Pa. The working parts are of forged steel. The machine work was done, under the personal supervision of Captain Crozier, at the Southwark Foundry & Machine Works at Philadelphia, Pa.

AMERICAN AND ENGLISH LOCOMOTIVES.

(*Continued from page 13.*)

SPECIFICATION OF ENGLISH EXPRESS PASSENGER LOCOMOTIVE.

LONDON & SOUTHWESTERN RAILWAY.

TENDER FOR FOUR-WHEELS COUPLED BOGIE PASSENGER ENGINES AND TENDERS.

DRIVING AND TRAILING-WHEEL CENTERS.

THE wheel centers to be of good sound cast steel, of approved make, free from honeycomb and other defects. One wheel center out of 40 is to be tested to destruction under the following conditions:

The wheel center is to be raised in a running position and allowed to fall upon a solid foundation from the following heights: 10 ft., 15 ft., 20 ft., 25 ft., 30 ft.

Should any wheel center break at the two lower heights—viz., 10 ft. or 15 ft., and show defects on hard material, the Railway Company's Locomotive Superintendent or his Inspector shall have the power to reject the whole. The wheels to be inspected on the premises of the maker.

Tensile test pieces are to be taken from the wheel center to give a breaking strain of not less than 28 tons per square inch, with an elongation of not less than 20 per cent. in 2 in.

Each wheel center is also to be tested by being allowed to fall in a running position a distance of 4 ft. 6 in. on to a wooden block without showing any signs of defect.

All the wheel centers must be bored and turned, and have keyways cut strictly to template, so that they shall be exactly alike, and each wheel must be forced on the axle before the tire is shrunk on by a hydraulic pressure of not less than 80 tons. The rims must be correctly turned to gauge to receive the tires, and the whole wheel trimmed up so that the surfaces and lines are all fair and true. The wheel centers are to be turned to a diameter of 6 ft. 7 in., the rims are to be $4\frac{7}{8}$ in. broad, $2\frac{1}{4}$ in. thick at center, to have 22 spokes $2\frac{1}{8}$ in. thick at the boss, and 4 in. deep, and at the rims $1\frac{1}{2}$ in. thick $\times$ $3\frac{1}{2}$ in. deep. The bosses are to be bored out parallel to a diameter of $9\frac{1}{2}$ in., and are to be 1 ft. 5 in. diameter. The cranks for the coupling-rods are to be cast solid with the bosses, 13-in. centers, and bored out parallel to a diameter of $5\frac{1}{2}$ in. to fit the coupling-rod crank-pins. The crank-pin holes are to be bored in a suitable quartering machine. The balance weights to be cast solid, and to be different for the driving and trailing wheels. Care to be taken that each wheel is cast with its proper balance weight. Generally the wheel centers must be as shown on the drawing.

BOGIE-WHEEL CENTERS.

The bogie-wheel centers are to be of good sound cast steel of approved make; quality, manufacture and tests same as specified for driving and trailing-wheel centers. Each wheel center to be turned to a diameter of 3 ft. $3\frac{1}{4}$ in., the rims are to be $4\frac{1}{8}$ in. broad, $2\frac{1}{4}$ in. thick at center, to have 10 spokes $1\frac{7}{8}$ in. thick at the boss and 4 in. deep, and at the rims $1\frac{1}{8}$ in. thick and $3\frac{1}{4}$ in. deep. The bosses are to bored out parallel to a diameter of 7 in., and are to be 1 ft. in diameter. The wheel centers must be bored and turned strictly to template, so that they shall be exactly alike. Each wheel center must be forced on the axle by a hydraulic pressure of not less than 70 tons. The wheel centers are to be fixed to the axles without keys.

TIRES.

The tires are to be of the best cast steel, manufactured by Vickers & Co., and are to be tested at the works of the maker in the following way:

Each tire is to be guaranteed to stand without fracture the repeated falling of a 1-ton monkey from a clear height, first blow 10 ft.; second, 15 ft.; third, 20 ft.; fourth, 25 ft.; fifth, 30 ft., and so on. Any tire which cracks or breaks before it has deflected one-sixth of its external diameter is to be rejected.

Test pieces are to be machined cold out of the tire without reheating the steel or treating in any way beyond cold machining for tensile test. The minimum tensile strength to be 44 tons per square inch, and to have an extension of not less than 15 per cent. in 2 in. A suitable and sufficiently large piece is to be sent to nine Elms for testing in a similar manner.

The contractor shall require the maker to provide at his own expense one additional tire for each 50 ordered, to be selected from the bulk by this Company's Locomotive Superintendent or his Inspector, and to be tested in his presence by the maker in the manner before described.

In the event of one tire cracking or breaking, or failing to stand the test, the company to have the power to reject the whole.

The number of the charge is to be stamped on each tire, and in the event of there being more than one charge in every 50 tires, a tire shall be selected from each charge and tested.

The maker's name and date of manufacture is to be stamped on each tire.

All the tires are to be 3 in. thick, of the form shown on drawing, and to be secured to the wheels with a lip and steel set screws $1\frac{1}{2}$ in. in diameter, 11 threads per inch. Each tire to be bored to gauge before being shrunk on the wheel center. Each tire to be accurately turned, so that the diameters and thickness shall be exactly similar.

AXLES.

All the axles must be of the very best cast steel, manufactured by Vickers & Co., and must be stamped with the maker's name and date of manufacture. Test pieces are to be made, giving a tensile strength of not less than 28 tons and not more than 32 tons per square inch, with an elongation of not less than 25 per cent, in 2 in.; a piece of a suitable length, $1\frac{1}{4}$ in. square, is to be bent double when cold without showing any signs of failure. The bogie axles to have centers of bearings 3 ft. 7 in., $5\frac{1}{4}$ in. diameter, 10 in. long. The driving and trailing-axles to have centers of bearings 3 ft. $9\frac{1}{4}$ in., 8 in. diameter, 9 in. long. All axles are to be as shown on drawings.

DRIVING AND TRAILING AXLE-BOXES.

The driving and trailing axle-boxes to be as shown on drawing, of the best gun-metal, and to have bearing surfaces of Dewrance's anti-friction metal: keeps to be of cast iron. The axle-boxes to have lubricating pads as shown. There is to be only one groove in the crown of the axle-boxes, with the lubricating holes leading into it. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle journal, to give clearance. The axle-boxes must have $\frac{1}{8}$ in. side play on each of the guides. Each axle-box must be made to gauges and must be duplicates of each other.

BOGIE AXLE-BOX.

The bogie axle-box to be of the best gun metal; keeps to be of cast iron, to have bearing surfaces and provision for lubrication, as shown on drawing. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle journal to give clearance.

DRIVING AND TRAILING SPRINGS.

The springs are to be made of the very best quality of spring steel, manufactured from Swedish bar iron. Five per cent. of the bars to be tested at the works of the makers by the Railway Company's Locomotive Superintendent or his Inspector in the following manner: A piece to be cut from each bar 2 ft. 6 in. long, heated and bent round to a radius equal to 80 times the thickness of the bar, then hardened and tempered. The camber to be taken after it has been pushed straight once in the testing machine, after which the bar must be pushed straight six times without showing any further permanent set. The tensile strength of the bars to be not less than 45 tons per square inch, with an elongation of not less than 15 per cent. in 2 in. Manufacture and brand to be approved by the Railway Company's Locomotive Superintendent. The plates are to be truly fitted, tempered and stamped with the maker's name and date of manufacture. The plates to be prevented from shifting side or end ways by nibs stamped upon them. Care must be taken that the nibs formed on the plates fit the slots properly. The buckles are to be sound forgings and are to fit the springs accurately, and are to be well secured to them, the buckles to be prevented from shifting on the springs by short wrought-iron pins, driven while hot through holes in the top and bottom of the buckle, and into a hole in the top plate and a recess in the bottom plate, as shown on drawing. The springs are to consist of 12 plates $\frac{1}{2}$ in. thick and 5 in. broad, to a span of 4 ft., and to have adjustable hangers at the end and solid hangers in the center. Each spring must be thoroughly tested before being put in its place, by being weighted with 11 tons, and on the removal of this weight the spring must resume its original form.

BOGIE SPRINGS.

The material, workmanship, method of construction and testing of the bogie springs must be the same as for the driving and trailing springs. The bogie springs are to consist of 14 plates $\frac{1}{2}$ in. thick, 5 in. broad, to a span of 3 ft. $11\frac{1}{4}$ in.

SPRING GEAR.

A compensating beam to be attached to the driving and trailing springs, of wrought iron, forged as shown on the drawing, and fitted with a phosphor-bronze bush, pressed into its place by hydraulic power. It is to be carried by a forged cross-shaft, which is to be carried by two forged brackets, as shown. The ends of the springs which do not engage with the compensating beam must be provided with suitable forged hangers, as shown. The whole of the spring gear to be forged in a sound manner, free from all defects whatsoever. The spring and compensating beam brackets to be attached to the frame by $\frac{7}{8}$ in. turned cold rivets of best Yorkshire iron, having a tensile breaking strength of not less than 22 tons per square inch, with an extension of not less than 30 per cent. in 2 in.

CYLINDERS.

The cylinders are to be 19 in. in diameter when finished, with a stroke of 26 in. The steam ports are to be 16 in. long and $1\frac{3}{8}$ in. wide. The exhaust port is to be 16 in. long and 3 in. wide. The bars are to be $1\frac{1}{2}$ in. wide. The cylinders are to be made of best close-grained, hard, strong cast iron; they must be as hard as they can be made, to allow of their being properly fitted and finished, and must be perfectly free from honeycomb or any other defect of material or workmanship: they must be truly bored out, the front end being bell-mouthed. All the joints, covers and surfaces are to be planed or turned, and scraped to a true surface, so that a perfect joint can be obtained. All studs are to be tightly screwed. The cylinders are to be made with loose covers at both ends, provision being made on the back cover for carrying the slide bar. They are to be set in a horizontal line, placed at a distance apart of 6 ft. $2\frac{1}{4}$ in. from center to center, with steam-chest on side as shown on drawing. The holes in the frames and flanges of the cylinders are to be carefully rimered. When the cylinders are correctly set to their places they are to be firmly secured to the frames by turned bolts $1\frac{1}{4}$ in. diameter, driven home a tight fit. The cylinders are to be covered with lagging and clothing plates 14 Standard W. G. thick. The front and back cylinder covers are to be protected by clothing plates secured as shown. The cylinders before being fixed in position to be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector, by hydraulic pressure to 200 lbs. per square inch. All joints must be perfectly tight under this pressure; the front and back cylinder covers and cylinders generally to be exactly to the drawing.

PISTON AND PISTON-RODS.

The pistons are to be made of cast steel, free from honeycomb or any other defects, to the form and dimensions shown on drawing, and are to be fitted accurately to the cone of the rods, and secured thereon by gun-metal nuts formed with collars, and taper steel pins through the nut. The piston-head is to be an easy fit in the cylinder; the packing rings are to be three in number, of cast iron $\frac{5}{8}$ in. wide, $\frac{1}{4}$ in. thick, and turned all over. The rings are to be turned larger than the diameter of the cylinders, then to be cut and sprung in to fit the bore in the cylinders, and are to be prevented from turning round in the piston by dowel pins fixed in the position shown. When finished, the whole must be an easy and accurate fit, so that the finished rod and piston can be moved readily backward and forward in the cylinder. The piston-rods are arranged to work through both front and hind cylinder covers, and to be $3\frac{3}{8}$ in. in diameter at back end and $2\frac{1}{2}$ in. at front end, and are to be forged from the very best cast steel of approved make, with a breaking strength of 30 tons per square inch; they are to be truly fitted to the heads, and are to be tapered where they enter the cross-head, and to which they are to be secured by cottars of mild Swedish steel. Full particulars of the various dimensions and tapers are to be obtained by reference to the full-size drawings.

METALLIC PACKING.

Both piston-rods to be fitted with the United States Metallic Packing Company's packing, which is to be obtained from that company. The hind cylinder cover is to be arranged, as shown on the detail drawing, to suit this packing, and the front cylinder cover to have a stuffing-box, which is also fully shown on the drawing.

SLIDE-VALVE.

The slide-valve is to be of the best Stone's bronze, to be made exactly as shown on the drawing, and with recesses in its working face.

VALVE-SPINDLES.

The valve-spindles and buckles are to be of best Yorkshire iron, and of the dimensions shown on drawing. The spindles are to be guided by gun-metal glands and bushes through the steam-chest; the valve-spindle is to be tapered where it enters the valve-rod, and is to be secured by a cottar of mild Swedish steel.

SLIDE-BARS.

The slide-bars (one to each cylinder) are to be of the very best Yorkshire iron thoroughly case hardened, 6 in. × 3 in., of a manufacture and brand to be approved by the Railway Company's Locomotive Superintendent: they are to be attached with $1\frac{1}{4}$-in. bolts to the back cylinder covers, which must be accurately fitted to receive them, and at the back ends they are to be attached with bolts $1\frac{1}{8}$ in in diameter to the motion-plate; a brass liner $\frac{1}{4}$ in. thick is to be placed at each end between the bar and carriers. Each bar is to have 15 lubricating recesses placed zigzag, 2 in. in diameter, on the top, with a $\frac{5}{8}$-in. hole in the recess leading to the bottom of the bar. Each bar to have a perfectly smooth true polished face all over the bearing surfaces.

CROSS-HEADS.

The slide-block rubbing pieces are to be of cast iron of the same metal as the cylinders, and are to be well provided with means of lubrication. The cross-heads are to be of the very best cast steel, free from honeycomb or any other defects.

The gudgeon-pins are to be of best Yorkshire iron case hardened, and are to be prevented from turning round in the cross-head by means of a key fitted in the outer jaw. The rubbing pieces are to be securely fixed to the cross-head with $\frac{3}{4}$ in. diameter turned bolts well fitted into the holes. Great care must be taken that the sleeve works freely on the bar.

VALVE MOTION.

The valve motion is to be of the curved link type, and the expansion links are to be hung from the center. The eccentric pulleys are to be in two parts, the smaller being of best Yorkshire iron, the larger of cylinder metal, and are to be fastened on the axle by means of keys and set screws as shown. The eccentric straps are to be of good tough cast iron, free from honeycomb or any other defect. The throw of eccentrics to be 6 in. The eccentric oil-cups are to be fitted with a button and spring. The eccentric rods are to be of best Yorkshire iron secured to the straps as shown. All the wrought-iron work is to be of best Yorkshire iron; the working parts are to be well and properly case hardened and re-cleaned up, and must be of the very best finish, and free from all marks and defects. All pins are to be of best Yorkshire iron, case hardened, 2 in. in diameter, and made to standard gauges. The motion is to be reversed by a screw gear fixed on trailing splasher on right-hand side of engine. The valve rods are to work through cast-iron guides bolted to the motion-plate.

The guides are to be bored out to fit the rods and to be made of cylinder metal, and to be provided with a lubricating box as shown. The guides are to be heated to a high temperature and then dipped in oil.

REVERSING-SHAFT.

The reversing-shaft to be forged from best Yorkshire iron. The levers are to be forged solid with the shaft, which is to be placed above the motion and carried by a cast-iron bracket with loose cap bolted to the frames with 1-in. bolts turned to gauge and made a driving fit; these brackets are to be made of cylinder metal, and bored out to $3\frac{1}{2}$ in. diameter to take the reversing-shaft. The working parts of the shaft are to be properly case hardened. The reversing-arm is to be on the outside of the bearing. The shaft is to be made as shown on drawing, and to be a sound forging in every respect.

CONNECTING-RODS.

The connecting-rods are to be of best Yorkshire iron, forged solid in one length, 6 ft. 8 in. from center to center, and are to be fitted with adjustable brasses of gun-metal at big end, and the small ends are to be fitted with gun-metal bushes accurately fitted and pressed into their places by hydraulic power. All bolts to be of best Yorkshire iron, and all cottars of mild steel; the cottars are to be accurately fitted, and provided with set screws and cross-cottars. The brasses at the big ends are to be lined with white metal. Oil-cups are to be forged solid with the big end straps; at the small ends a recess is to be made for lubrication.

COUPLING-RODS.

The coupling-rods are to be forged from best Yorkshire iron and machined out, to form the H section; the ends are to be

accurately fitted with gun-metal bushes, pressed into their places by hydraulic power, so as to insure a perfectly tight fit, and to be secured as shown; the bushes to have five grooves ¼ in. wide and $\frac{3}{16}$ in. deep, fitted with white metal. All oil-cups for connecting-rods, coupling-rods and eccentric straps to be provided with a button and spring, and are to be duplicates. The rods must be made in every particular as shown clearly on the detailed drawing.

CRANK-PINS.

The crank-pins are to be of best Yorkshire iron properly case-hardened on the wearing surface. The hole in the wheel is to be parallel as shown; the pins are to be accurately fitted and pressed into the wheels before the tire is shrunk on by hydraulic power of not less than 30 tons, and riveted over on the inside. Cottared washers are to be placed on the ends as shown on detail drawing.

STEAM PIPES.

The steam pipes in the smoke-box to be of copper, No. 6 Standard W. G., and 4 in. inside diameter, to have gun-metal flanges at both ends properly brazed to the pipes and accurately faced so as to secure steam-tight joints. Each steam pipe is to be led to the cylinder and is to be secured to the same with studs and brass cover-ended nuts.

VORTEX BLAST-PIPE.

The blast-pipe to be Adams's Patent Vortex, of the form and dimensions shown in the drawing, with an annular exhaust. The blast-pipe is to be secured to the cylinder with studs and brass cover-ended nuts.

BRAKE.

The engines are to be fitted with a steam and an automatic vacuum brake. The brake material, which must be obtained for each engine from the Vacuum Brake Company, 32 Queen Victoria Street, E. C., will consist of one combination ejector, one steam cock for ejector, one automatic steam-brake valve on left-hand side of engine, one vacuum gauge, one drip recipient, one dummy, one of Clayton's hose and couplings for front of engine, one of Clayton's hose and couplings for connecting main air-pipe of engine to tender, one wrought-iron pipe from ejector to smoke-box passing through the boiler on right-hand side of engine, main air-pipe, with the necessary T pieces, elbows and clips, one end pipe with cast-iron bend for front of engine. The brake material, which will be supplied by the contractor, will be as follows: One steam-brake cylinder with piston and rod complete; one copper pipe, 2 in. inside diameter, No. 10 Standard W. G., leading from the ejector to the trailing end of the engine; one copper pipe 1¼ in. inside diameter, No. 10 Standard W. G., leading from the steam cock on the boiler to the top of the ejector; two copper pipes ⅝ in. inside diameter, No. 14 Standard W. G., one from the automatic steam-brake valve for supplying steam to the cylinders, the other leading to the ash pan; one copper pipe ¼ in. bore, 16 Standard W. G., leading from the union on the main air-pipe below the ejector to the steam-brake valve; one copper pipe ¼-in. bore, 16 Standard W. G., leading from steam-brake valve to vacuum-gauge; one wrought-iron pipe 2 in. inside diameter, No. 7 Standard W. G., leading from the smoke-box tube-plate to the bottom of the chimney, to have a hole ⅜ in. in diameter at bottom of bend.

The driving and trailing-wheels are each to have one cast-iron brake-block applied to them. The brake gear is to be provided with adjustment, and made of the best hammered scrap iron, all the pins and working parts being case hardened. The pins through all points of suspension of levers are to be 2 in. in diameter, and to have brass bushes where shown; the brake gear must be as shown on drawing.

INJECTORS.

Two No. 8 gun-metal injectors, Dewrance's patent, with removable half cones, are to be fixed one on each side of engine as shown, to deliver into clack-boxes placed at front end of boiler. The delivery pipes are to be of copper, 1¼ in. inside diameter, No. 8 Standard W. G. thick. The steam pipe is to be of copper, 1¼ in. inside diameter, No. 10 Standard W. G. thick. The overflow pipes are to be of copper, 1 in. inside diameter, No. 10 Standard W. G. thick. Care must be taken that the pipes are so set that the flanges of all joints come fairly to their places without any spring upon them. The pipes are to be solid drawn and perfectly uniform in length, and set so that any pipe will fit into its respective place on any engine equally well. The injectors are to be fitted with a feed-pipe arrangement as shown. The hose pipes are to be connected to the injectors by a brass casting.

BOLTS AND NUTS.

The bolts and nuts are to be made exactly to the lengths and sizes shown on drawing, and are to be Whitworth's standard. All are to be finished bright where not otherwise specified. All nuts are to be case hardened. All nuts inside smoke-box are to be of hard brass with blank ends.

CLOTHING.

The boiler and fire-box are to be lined with felt and well-seasoned pine in strips of not more than 2½ in. wide × ¾ in. thick, tongued, grooved and painted with asbestos fireproof paint on both sides, the whole to be neatly covered with clean and smooth steel sheets, No. 14 Standard W. G. thick, to be kept 1½ in. above the fire-box, and carried parallel the whole length of the boiler and fixed at top by angle-iron as shown, the steel sheets to be secured at the joints with hoop-iron bands 2½ in. wide, with tightening screws at the ends; the beading on front end of boiler to be of sheet brass to the shape shown on drawing, and finished to a perfectly clean and polished surface. The manhole casing is to be of charcoal iron, No. 14 Standard W. G. thick, and is to be fitted with a cast-iron shield for safety-valve columns. The dome casing is to be of charcoal iron, No. 14 Standard W. G. thickness, brazed up solid and painted.

CAB.

The sides and front are to be of Best Best Staffordshire iron $\frac{9}{16}$ in. thick. The roof is to be of wood, tongued and grooved, and covered with oil cloth to this company's pattern; the roof is to be supported by angle irons and an iron strip as shown; a ledge is to be formed at each side, to prevent water falling on the men. The cab is to have two windows of best polished plate glass, ¼ in. thick, in brass frame, hinged on the top and provided with fastenings as shown. The front edges of the cab and top of hand-rail plate are to be stiffened with angle-iron and beading polished. A hand-rail finished bright is to be fixed on each side of the engine outside the cab. A cord communication to the whistle is to be provided on the outside of the cab on right-hand side of engine as shown on drawing.

GENERAL MOUNTINGS.

Each engine is to be supplied with the following: One Ramsbottom's duplex safety valve with cast-iron columns and brass valves and seats, the springs to be set so that when the eye-bolt is screwed down to the shoulder the steam shall blow off with a pressure of 175 lbs. per square inch in the boiler. One of Bourdon's pressure gauges, 7 in. in diameter, to indicate up to 200 lbs. pressure, to this company's pattern. Two water-gauges complete with flanges, Dewrance's patent, with glass guard, and with pipes leading to the ash-pan. One large and one small whistle. Two steam cocks, Dewrance's, for the supply of the injectors, to be fixed with the whistles to one seating on top of fire-box. One blower-cock placed on side of smoke-box worked by a wheel and screw-valve from foot-plate on right-hand side of engine; and a copper pipe is also to be led from blower-cock through the smoke-box to the top of exhaust-pipe, and one from the blower through the tube-plate to the dome. Two clack boxes, one on each side of the boilers. Two drain cocks to each cylinder, to be worked from the foot-plate as shown; one lubricator fixed on each side of smoke-box, with pipe leading to steam-chest. One lubricator screwed into each front cover of cylinder. One oil-box and pipes led down to top of each piston-rod and valve spindle glands, and fixed as shown. One lubricating-box is to be placed over the leading and driving axle-boxes with pipes leading to the axle-boxes and guides. One watering-cock attached to the injector delivery pipe on left-hand side of engine. One regulator quadrant and stuffing-box complete finished bright. Four tapered plugs, one in each bottom corner of fire-box 1⅛ in. in diameter, 12 threads per inch. Three filling tapered plugs on back of fire-box 1⅛ in. diameter, 12 threads per inch. Four tapered wash-out plugs, two on each side of back of fire box above foot-plate, 1⅛ in, in diameter, 12 threads per inch. Eight wash-out taper plugs in smoke-box, 1⅛ in. in diameter, 12 threads per inch. One wash-out hole with covering plate on each side of fire-box at bottom. One wash-out hole with covering plate in front and back of fire-box. Two small tool boxes with padlocks and keys, one box to be hung on each side of engine inside the cab. One water-gauge lamp bracket to this company's pattern fixed on the tray over fire-door. Five lamp-irons at front of engine to this company's pattern, four to be fixed on front of smoke-box, one on front of buffer plate. All plugs and mountings are to be of gun-metal, and must be of first-class finish. Pitch of threads for mountings is to be 12 threads per inch, unless otherwise shown on drawing.

The injector and whistle seatings and valves, blower cock,

clack-boxes, water-gauges, cylinder and steam-chest lubricators are to be to this company's pattern.

TOOLS.

Each engine is to be supplied with the following tools: One complete set of spanners, including two gland and two mud plug spanners; one punch for tapered pins; one large round drift for motion pins; one flat drift for cottars; one large monkey-wrench; one small monkey-wrench; one hand hammer; one quarter hammer; one pinch bar; two chisels; one pair of tongs; one bunting bar; one traversing screw-jack and ratchet, which must be exactly *to this company's pattern*; one oil can, 16 lbs.; one oil can, 8 lbs.; one oil can, 4 lbs.; one tallow can; one tallow feeder; two oil feeders to pattern; one pricker; one rake; one fork; one coal-pick; one shovel.

Three head lamps, two water-gauge lamps, and one hand-lamp are to be supplied to this company's pattern. A sample set of fire irons will be supplied by this company.

PAINTING.

Before any paint is applied, the iron-work must be cleaned and be free from scales and rust. The boiler is to receive one coat of boiled oil while warm, and two coats of Torbay red oxide paint, before being lagged. The inside of clothing to receive one coat of red oxide. The outside of clothing plates, plates, wheels, the sides and front of cab, and sides of splashers, to have one coat of lead color, two coats of filling-up, stopped with hard stopping, then rubbed down, followed by two coats of lead color faced with pumice stone between, after which two coats of light green to pattern. The picking-out and fine lining are to be to pattern panel, which will be supplied by the company. The outside of frames, guard-bars, tops of splashers, smoke-box, chimney, back of fire-box, ash-pan, foot-plate, brake work, and side springs are to have one coat of lead-color paint and two coats of japan black. The inside of frames and cross-stays to have one coat of Torbay red oxide and one coat of tan color to pattern. Front of buffer plates and buffer casing to be painted vermilion; inside of cab to have one coat of lead color, two coats of filling-up, and two coats of tan color to pattern. The axles are to have one coat of lead color, and one coat of Japan black. All the painting on the outside of the engine to have three coats of the best engine copal varnish of the very best quality, and flatted between the coats.

TESTING.

The boiler must be tested before being lagged with warm water to 262 lbs. per square inch, or to one and one-half times the working pressure; to be tested in steam to 175 lbs. per square inch, and to be thoroughly tight under each test. The boiler is to be tested in the presence of the Railway Company's Locomotive Superintendent or his Inspector.

QUALITY, ETC.

All the materials and workmanship are to be of the very best description, and all the various parts are to be applied in the best and most approved manner.

All the iron-work is to be stamped with this company's initials.

The contractor will be required to make complete general and detail drawings of the engines and tenders, and to supply this company with two complete sets of cloth tracings of them, free of charge. Great care must be taken that all parts of the engines are precisely of the dimensions shown, so that they may be duplicates of each other.

One of the engines and tenders is to be photographed at the contractor's expense, and twelve copies are to be supplied to the company. All the working parts of the machinery are to be well case hardened. The number of engine is to be figured in gilt numbers on front buffer plates, and by solid brass number plates on the hand-rail plate on each side of the engine. Samples of the gilt numbers and drawing of the brass number plates will be supplied by the company.

Specification of Six-Wheels Tender.

DRAWING NO. 6,740.

Principal Dimensions.

	Ft.	In.
Diameter of wheels on tread	3	9¼
Center to center of journals	6	6
Length of journal	0	9
Diameter "	0	5¼
Diameter of axle in wheel	0	6¼
" " at center	0	6½
Wheel-base	13	0
Length of frame	19	9½
Total length of wheel-base from center of leading bogie wheels of engine to center of hind wheels of tender	44	3⅛
Length over all, from front buffers of engine to hind buffers of tender	53	8⅝
Height of center of buffers from rails	3	5
Capacity of tank	3,300 galls.	

TANK.

The tank to be of the form shown. The tank-plates are to be of the Best Best Staffordshire iron. Each side-plate of the tank is to be in one, ¼ in. thick. The bottom-plate of the tank to be ⅜ in. thick, jointed as shown, and to form the foot-plate of tender. The height of top of foot-plate from rail to be 4 ft. 1½ in. The end and front-plates to be ¼ in. thick. The top to be made of two plates $\frac{5}{16}$ in. thick, jointed as shown. A stiffening plate ⅜ in. thick to be riveted to the top of the tank at the front end. The tank to be thoroughly stayed by plates, angle and tee-irons in the manner shown. The front-plate is to be cut out to form a doorway for coaling, and is to be fitted with a door hinged from the bottom, and secured at the top by suitable fastenings. Two wrought-iron tool-boxes are to be provided at the front of the tank, one on each side of the tender. Another tool-box is to be fixed across the tank on the top at the back. All tool-boxes to be fitted with false bottoms, perforated with small holes, and to be perfectly water-tight at the top; the tool-boxes are to be provided with padlocks and keys. The tank to be provided with a manhole or tank-filler and lid 1 ft. 6 in. in diameter, to which is to be attached a suitable sieve as shown. The angle-irons throughout to be 2½ in. × 2½ in. × ⅜ in. The tank to be riveted up with ½-in. rivets 1⅛ in. pitch, countersunk outside in the sides and end of the tank. The coping plates which are attached to the sides and end of the tank to be finished with a wrought-iron half-round molding piece as shown. Tank and well to be made entirely independent of the framing, and fixed as shown. A well to be provided 13 ft. 3¾ in. long, 3 ft. 11 in. broad, and 1 ft. 6 in. deep, of plates ¼ in. thick, stayed and riveted in the same way as the tank. One filling-cock for bucket is to be fixed on right-hand side in front of tank as shown. A wash-out plug is to be fitted to the bottom of the well.

One hand-rail is to be fixed on each side of the back of the tank, and is to be finished bright; four lamp irons to this company's pattern are to be fixed on the back of the tank, and one lamp iron on each side of the tank, as shown.

FRAME.

The frame-plates, cross-stays, stretcher-plates, hind buffer-plates to be of steel, same quality and manufacture in every respect as specified for the engine main frames.

Each frame is to be made of one plate, ¾ in. thick, and all holes are to be marked and drilled from one template. The axle-box guides are to be made of cast iron, planed, fitted, bolted to frame, and must be free from cross-winding and square with the frames in all directions. The horn-stays are each to consist of two 1⅛-in. bolts with cast-iron distance pieces accurately fitted between the horns. All the cross-stays are to be accurately fitted to the frames and riveted to them by ⅝ in. diameter rivets. The frames are to be accurately tested by longitudinal, transverse and diagonal measurement, and must be perfectly parallel to each other. The front buffing and draw-beam is to be constructed as shown, and is to be provided with buffers, fitted with volute springs, to this company's pattern. The draw-bar is to be forged in one, the hole at one end being punched. Wrought-iron steps are to be provided, roughed and fixed where shown. The hind buffing and draw plate is to have a draw-hook and bar furnished with one of Spencer's No. 6 india-rubber cylinder to this company's pattern, two cast-iron buffers the same as specified for the engine, two side chains and screw coupling made of best chain cable iron, and to drawing. Two steel life guards are to be bolted to the frame behind the hind wheels.

AXLE-BOXES.

The axle-boxes are to be made of cast-iron fitted with a wrought-iron top and with the best gun-metal bearings lined with Dewrance's anti-friction metal, and to have cast-iron keeps provided with lubricating pads. The axle-box bearings to be $\frac{1}{16}$ in. shorter than the axle-journal to give clearance; front and hind axle-boxes must have ⅛ in. side play, and the center axle-box ¼ in. side play on each side of the guides, as shown on drawing.

SPRINGS.

Tender springs to be of same quality, workmanship and manufacture as specified for the engine springs. Each spring to consist of 16 plates, one plate ½ in. thick and 15 plates $\frac{7}{16}$ in.

thick to a span of 4 ft., each spring to be provided with hangers at the ends, and buckles in the center, as shown. Each spring to be tested with a weight of 8 tons, and must resume its original form after testing.

WHEEL-CENTERS.

The wheel-centers to be of good sound cast steel of approved make, quality and manufacture, and tests same as specified for engine. Each wheel-center to be turned to a diameter of 3 ft. 3¾ in.; the rims are to be 4¾ in. broad, 2⅝ in. thick at center, to have 10 spokes 2½ in. thick at the boss and 4 in. deep; at the rims 1¾ in. thick and 3½ in. deep. The bosses are to be bored out parallel to a diameter of 6¾ in., and are to be 11¾ in. diameter. All the centers must be bored and turned strictly to template, so that they shall be exactly alike, and each wheel-center must be forced on the axle by a hydraulic pressure of not less than 70 tons. The wheel centers are to be fixed to the axles without keys.

TIRES.

The tires to be 3 ft. 9¾ in. diameter on tread, and in every other respect to be same as the engine tires, both as regards section, quality of material, and workmanship, and to be manufactured by Vickers & Co. The same tests to be applied as for the engine tires.

AXLES.

Each axle must be made of the very best cast steel, quality and tests as specified for the engine axles, and to be manufactured by Vickers & Co. Centers of journals to be 6 ft. 6 in.; diameter 5¼ in. and length 9 in.; other dimensions as shown on drawing.

SAND-BOXES.

Two cast-iron dry sand-boxes with circular valves are to be fixed in front of the tender. Sand-pipes are also to be fixed as shown, the sand to be led within 3 in. of the rails by wrought-iron pipes 1½ in. inside diameter. The general arrangement of sand-boxes and gear are shown on drawing.

FEED-PIPES AND COCKS.

Two feed-cocks to this company's pattern, to be fixed at the bottom of the well as shown, two copper pipes 2-in. bore, 8 Standard W. G., to connect the feed-cocks with the gun-metal stuffing-boxes, as shown. Strong hose pipes to be provided, clipped at the tender end to the stuffing-boxes, and at the engine end to the feed castings. The copper pipes to be fixed by suitable clips, the whole arrangement to be as shown.

STEAM-BRAKE.

A steam and hand-brake combined is to be fixed on tender as shown; the cylinder, 10 in. in diameter, is to be provided with means of lubrication; the brake-screw, which is to be left handed, is to work in a cast-iron column bolted to the foot-plate at the front end of the tender, and the front pulling-rod is to be provided with adjustment as shown; each wheel is to have one cast-iron brake block applied to it. The brake gear is to be made of the very best hammered scrap iron, all the pins and working parts being of wrought iron case hardened, all pins to be to drawing and to have brass bushes where shown. The steam is to be led from the engine to the cylinder with a connection as shown.

The brake material, which must be obtained from the Vacuum Brake Company, 32 Queen Victoria Street, E. C., for each tender, will consist of one main air pipe with the necessary T-pieces, elbows and clips, one of Clayton's hose and couplings for front of tender, one of Clayton's hose and couplings for back of tender, one end pipe with cast-iron bend, one dummy, one drip recipient. The brake cylinder, piston and rod complete are to be supplied by the contractor. The brake gear generally to be as shown on drawing.

PAINTING.

Before any paint is applied, the iron-work must be clean and free from scales or rust. The inside of the tank to have two good coats of thick red-lead paint, the outside being prepared and finished in a similar manner to the engine. The top and bottom of the tank, foot-plate and brake-work are to have one coat of lead-color paint, and one coat of japan black.

The gilt numbers are to be put on the tender buffer-plate, and letters on sides and small numbers on ends of tenders, according to instructions and samples which will be supplied, and all the iron-work is to be stamped with this company's initials.

GENERAL CONDITIONS.

The engines and tenders must be made to the dimensions given in the foregoing specifications, and to drawings to be supplied by the Company's Locomotive Superintendent, except in cases where his consent to an alteration has been obtained in writing.

The quality of the materials to be of the make specified, and when no instructions are given, both materials and workmanship are to be of the best of their respective kinds, and all the working parts interchangeable.

Before ordering any material, the contractors must first submit to the Locomotive Superintendent, for his approval, the names of the firms from which the contractors propose to order the material, and obtain in writing his sanction to the same.

Complete detail drawings will be supplied on application to the Locomotive Superintendent which must be accurately worked to, and no advantage is to be taken of any omission of details in the specifications or drawings, as the contractors may obtain on application to the Locomotive Superintendent a full explanation of any part of the work not sufficiently shown or understood.

The engines and tenders must be finished and complete in every respect, and to the entire satisfaction of the Locomotive Superintendent, who shall be at liberty to inspect, either personally or by deputy, the work during its progress, and to reject any defective or unsuitable materials or workmanship.

The Locomotive Superintendent also to have the right of testing from time to time, as specified, or by additional tests, any portion of the material used in this contract. The tests may be made either at the works of the contractors, the company's own works at Nine Elms, or those of any other firm he may hereafter decide upon, and should the tests not appear sufficiently satisfactory to the Locomotive Superintendent, he may reject the whole or any portion of the material. The entire cost of all tests of materials, whether chemical or mechanical, that may be required by the Locomotive Superintendent, must be made at the expense of the contractors, including both the cost of the material and the preparation of the same for testing.

The engines and tenders are to be delivered by the contractors, free of charge, to the railway company at Nine Elms fit and ready for work; and prior to payment in the usual way at the end of the second month after delivery, each engine and tender will be required to run 1,000 miles consecutively without showing any defects in materials or workmanship, and the contractors will be held responsible for all defects that may appear, accidents excepted, until they have run that distance. In the event of the engines and tenders not being delivered at the time and in the numbers specified, the company reserve to themselves the right of delaying the payment, proportionate to the amount of delay in the delivery of the engines and tenders.

All royalties and patent rights to be paid by the contractors.

In case of any dispute arising, either during the progress of the contract or at its termination, the decision of the Company's Locomotive Superintendent is to be taken as final and binding in every respect

APPARATUS FOR RAPID LOADING OF COAL INTO SHIPS.

By G. Braet.

The swinging hydraulic hoist for coal, or the hydraulic kolentip built for the Rotterdam docks, by the Armstrongs, of England, and forming a portion of the plant of Feyenoord, is one of the latest applications of this system of loading coal. The accompanying engravings show, fig. 1, plan, and, fig. 2, a photographic reproduction of the plant and its method of operation. We also subjoin to the end of this article an extract from the regulations regarding the use of this swinging crane.

Another apparatus for loading coal is the Marillier hydraulic elevator of the Albert dock, at Hull, in England, built by the Hydraulic Engineering Company, of Chester, and it is shown by the engravings, fig. 3. This elevator is built on the continuous system—that is to say, the coal cars enter from one side by a side track, are raised to the requisite height, and are then unloaded, and afterward descend and go out on the side track on the other side of the elevator. The use of turn-tables, which are necessary in other systems, are therefore not required in this case, so that there is considerable saving in time and expense.

The apparatus consists of a wooden framework in which three platforms are located: two are movable and one fixed where the hydraulic machine and shute is located. The movable platforms on either side are used respectively for raising the loaded cars and lowering the empty ones. The stationary platform of the machine contains the hopper into which the

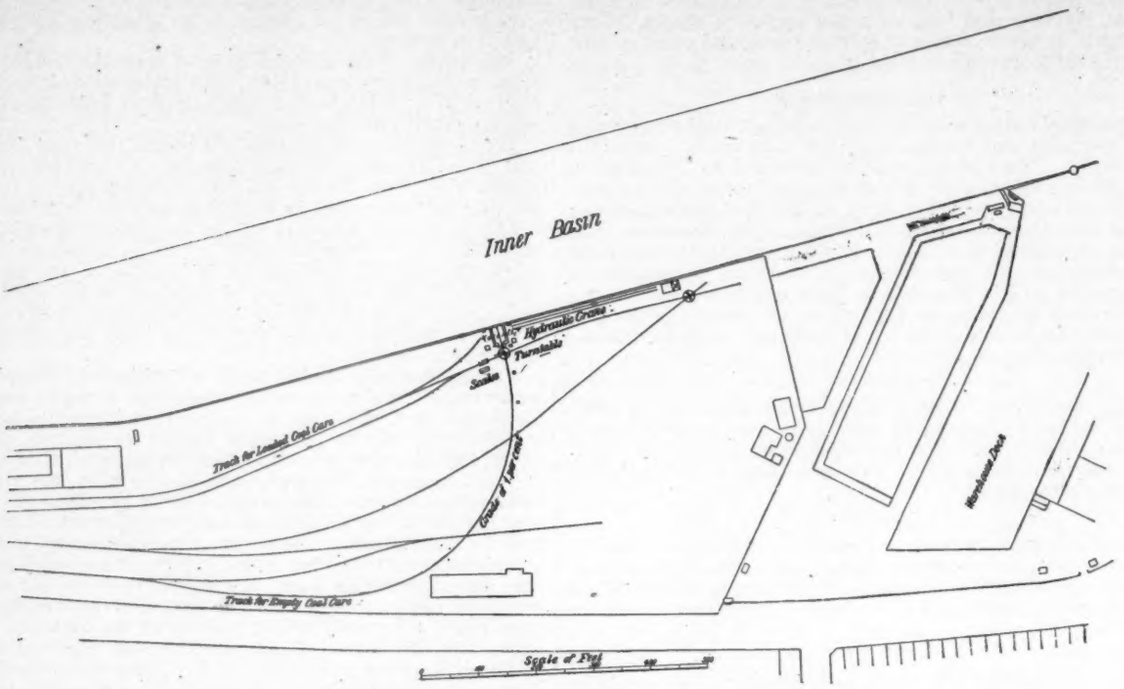


Fig. 1.

PLAN OF HYDRAULIC KOLENTIP AT ROTTERDAM, HOLLAND.

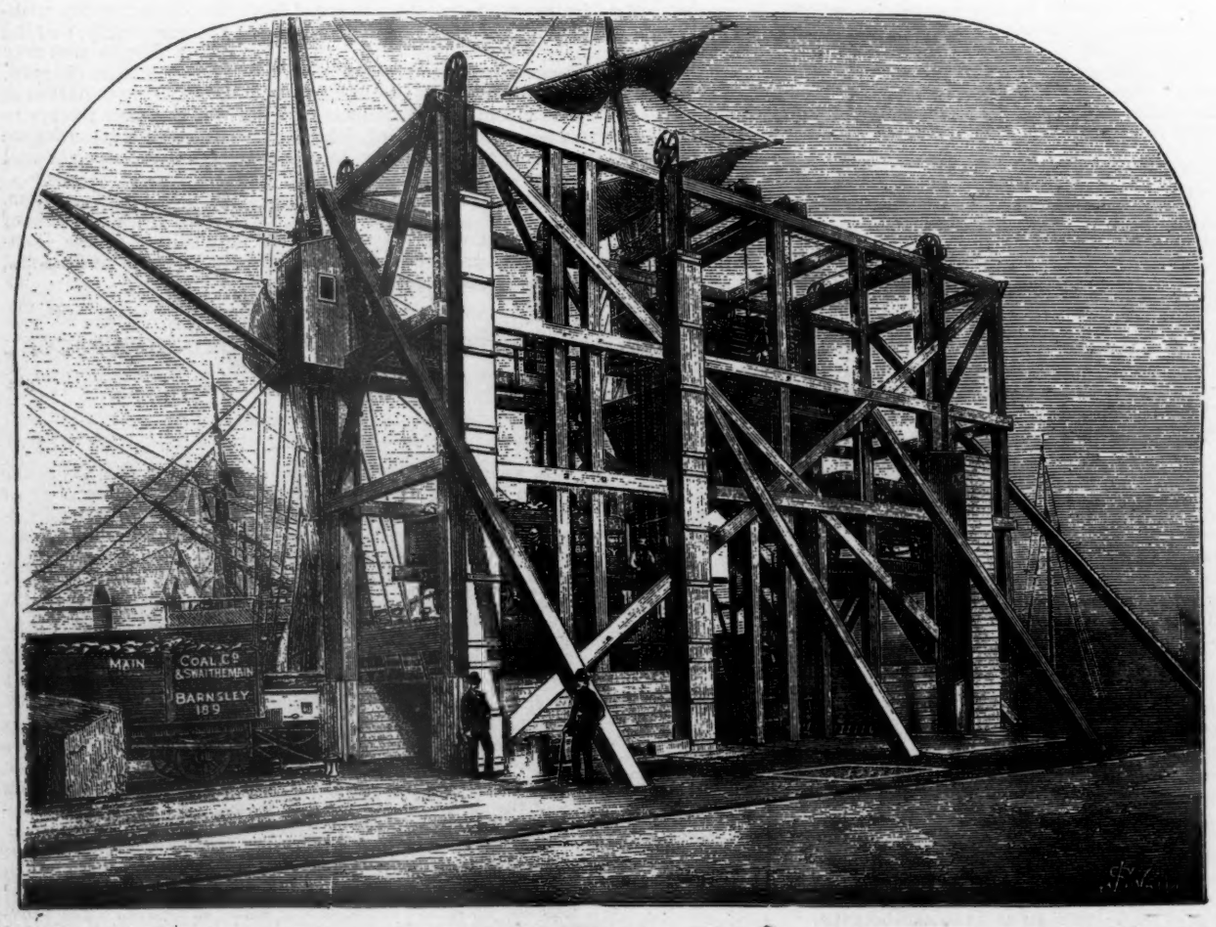


Fig. 3.

MARILLA HYDRAULIC ELEVATOR, ALBERT DOCK, HULL, ENGLAND.

coal is unloaded from the car. The method of operating the elevator is as follows: The full cars, having been hauled on to the first platform, are raised to a height of 28 ft. at least by a hydraulic direct-acting lift fixed in one of the pits under the platform. If the cars are hopper-bottom cars, they run out on to the center of the platform and are there unloaded, and then, after having been run upon the descending platform, drop down and are hauled out on to the track and coupled to the other empty cars which have preceded them. The rails of the three platforms are located on a slight incline so that the car is easily moved from one to the other. The engravings show three cars being handled at the same time. One full car is going up; a second is being emptied, and a third, which is already emptied, is coming down.

In the mean time the cars are being hauled up to the elevator by a capstan driven by a three-cylinder hydraulic motor built by Brotherhood. With hopper-bottom freight cars this elevator can handle about 300 tons an hour.

For some years past coal has been loaded into vessels at the James Watt Dock, at Grenock, by means of traveling cranes with a capacity of about 25 tons, which were built by Mr. Appleby. The boom of this apparatus has a swing of 21 ft. 2 in. beyond the end of the quay, and at this height it is about 78 ft. 9 in. above the level of the water. It can lift and turn in all directions, and is evidently built in such a way that it handles coal with great facility and so that either of the tracks on the quay can be used for the reception of loaded or empty cars. The turning portion of the crane is mounted on a movable framework traveling over two tracks with the standard gauge of 4 ft. 11 in.

The rails which carry the crane itself are placed at a distance of 5 ft. 11 in. on either side of the ordinary track, so that the gauge of the track of the crane is 28 ft. 2.6 in. The height of the opening is such that locomotives and the largest loaded cars can pass beneath, so that the crane can lift anything which can come on to the quay without opposing any obstacle to the movement of the rolling stock and without cramping the space which could otherwise be utilized. The motive power used is steam from the crane engine; and the capstans, which are also driven by steam, are fitted to the frame for the purpose of handling loaded or emptied cars. The following is the method of operation: As soon as the car is caught in the cradle which is suspended to the lifting chain, they attach the chain which controls the tumbler. The drums are then started and the car is raised to the desired height; the brake is applied to the drum of the traveling chain and the other chain is slackened off. The car is thus held by the back side and the contents are discharged; then the car is placed upon the track for empty cars. The operation of turning and raising takes place at the same time, and requires three minutes to raise a car perfectly, regardless of its capacity. The engraving, fig. 4, which is herewith given, shows the traveling Appleby Crane.

At present there are some arrangements used in France in the Department of the North of Calais, including the immense coal basin, which comprises, as we know, one-thirtieth of the concessions, and the annual production of which is given in their report as more than 1,000,000 tons. The transportation by canal being cheaper than by railroad, some companies, and these the most important, have made a connection between their docks and the canals; the Lens Company, as well as the Noeux-Bruay companies, have built loading wharves for their coal; and this latter, after having been loaded on cars at the mines, is hauled to a point near the docks and unloaded into boats by means of tumblers and cranes.

The mechanism used must satisfy the following conditions: To unload the coal without a shock being given to any part of the boat, and still keep it in the uniform merchantable condition; second, to reduce the work of leveling off as much as possible—that is to say, the redistribution of the coal down to a suitable deck level after the loading; third, to work rapidly.

The Mechanisms of the Société Charbonnière de Lens (*Figs.* 5 to 8).—The different points of this coal-handling station are connected to the coal-loading station by a network of tracks having a total length of more than 12.4 miles, and which include more than one-half the tracks about the station. They run along the dock for a distance of 903 ft. There are 50 hoppers distributed along the railroad, over which the coal cars are stationed and the contents of which are dumped into the hoppers; a machine with a circular crane on a parallel track successively lifts each car. The whole of the system includes, first, a hopper used as an intermediate between the car and the vessel; second, a special machine equipped with a crane intended for raising the body of the cars. A word of explanation is necessary regarding each of these two installations. First the hopper: each hopper may be considered as composed of a fixed and movable portion. The fixed portion is composed of cast-iron plates fastened to the masonry wall of the wharf by means of pieces of wood built into the mason work. This fixed portion narrows down toward the edge of the wharf and has two inclinations. At the top it is 42°, and toward the bottom, where the inclination is the greatest, it is 50°. The movable portion includes a shute and a neck. The shute is formed of sheet metal, and is arranged so that it can be fixed at different inclinations, in order to regulate the height of the

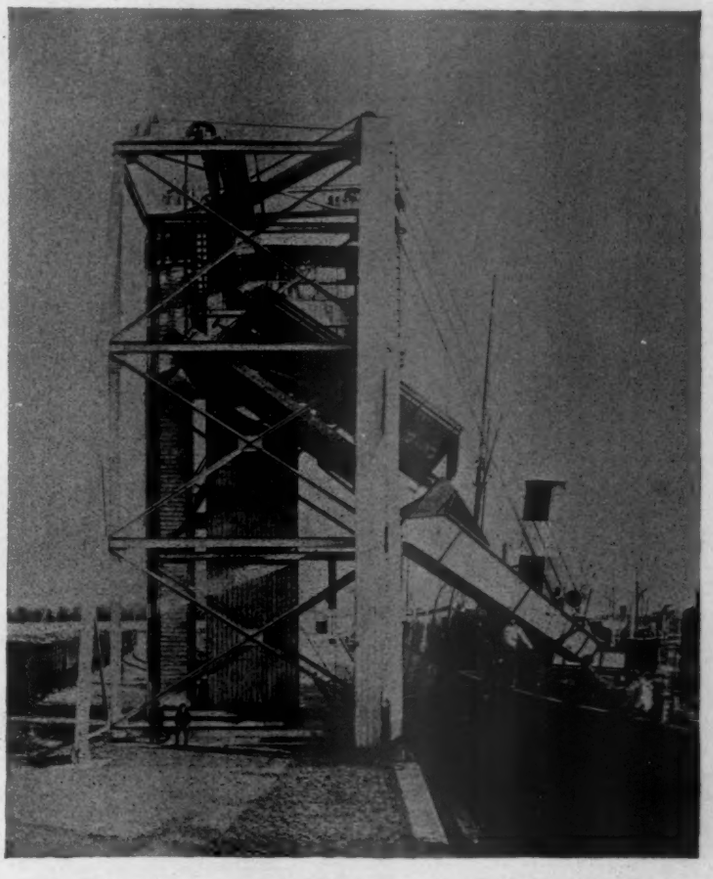


Fig. 2.

HYDRAULIC KOLENTIP AT ROTTERDAM, HOLLAND.

fall of the coal from the hopper into the boat, in order that the coal may not be broken or injure the boats. The neck is pivoted at the end of the shute and can be put in different positions, permitting the distribution of the coal along the whole length of the vessel. A sluice gate closes the opening of the fixed hopper when the boat is not ready to receive its load at once. Counterweights balance the weight of the movable shute, and thus make its manipulation easy.

Methods of Transportation.—The Société de Charbonnière de Lens uses single box cars, which have been found to be particularly satisfactory. The box of these cars is made of iron, and stands directly on the frames; the capacity of the box is limited transversely by pieces fastened to the car's sills, which abut directly against the longitudinal sills of the car. The sides of the car are movable; the center is formed of two panels opening vertically, and the ends can swing about a horizontal hinge fastened to the upper portion of the box. The opening of the doors at the level of the frame is provided for.

Motor Apparatus.—The motor apparatus, as we have already said, is a supplementary steam crane placed alongside of the machine to which it is attached. The boom of this crane is surmounted by a pulley over which a chain passes which has

a hook at one end intended to catch beneath the box of the car and raise it when steam is admitted into the cylinder of the crane. The manipulation of this mechanism is as follows: The machine, after having placed the loaded cars on the track alongside the hoppers, runs out on a parallel track and stops consecutively opposite each car. The hook of the crane is placed beneath the box. The side parts are set free from the sides of the hoppers, and then the crane is set at work and the box is inclined, and the side doors opened so that the coal is dumped into the fixed hopper. After having lowered the box into its place, the machine is advanced to a point opposite another car, and the same operation repeated. When the coal is to be dumped from the fixed hopper into the boat it is merely necessary to open the gate which is flush with the wall of the wharf, and the coal is allowed to run down into the movable shute and from thence into the neck; by working the crabs located on the top of the wall of the wharf, whence the neck is so handled as to distribute coal conveniently into the boat. The raising of the single box is accomplished without any difficulty whatever; the oblique direction which the chain of the crane takes, and the arrangement of the axis of rotation contribute to give sufficient stability to the whole of the car. With the Lens apparatus 300 tons of coal can be loaded per hour. Figs. 5 to 8 also show an arrangement which has been adopted by the Lens Company for turning coal cars into the tilting barrels which are to transport it. This method of unloading coal can be used at important points where the level of the track is located above that upon which the tilting cars are run.

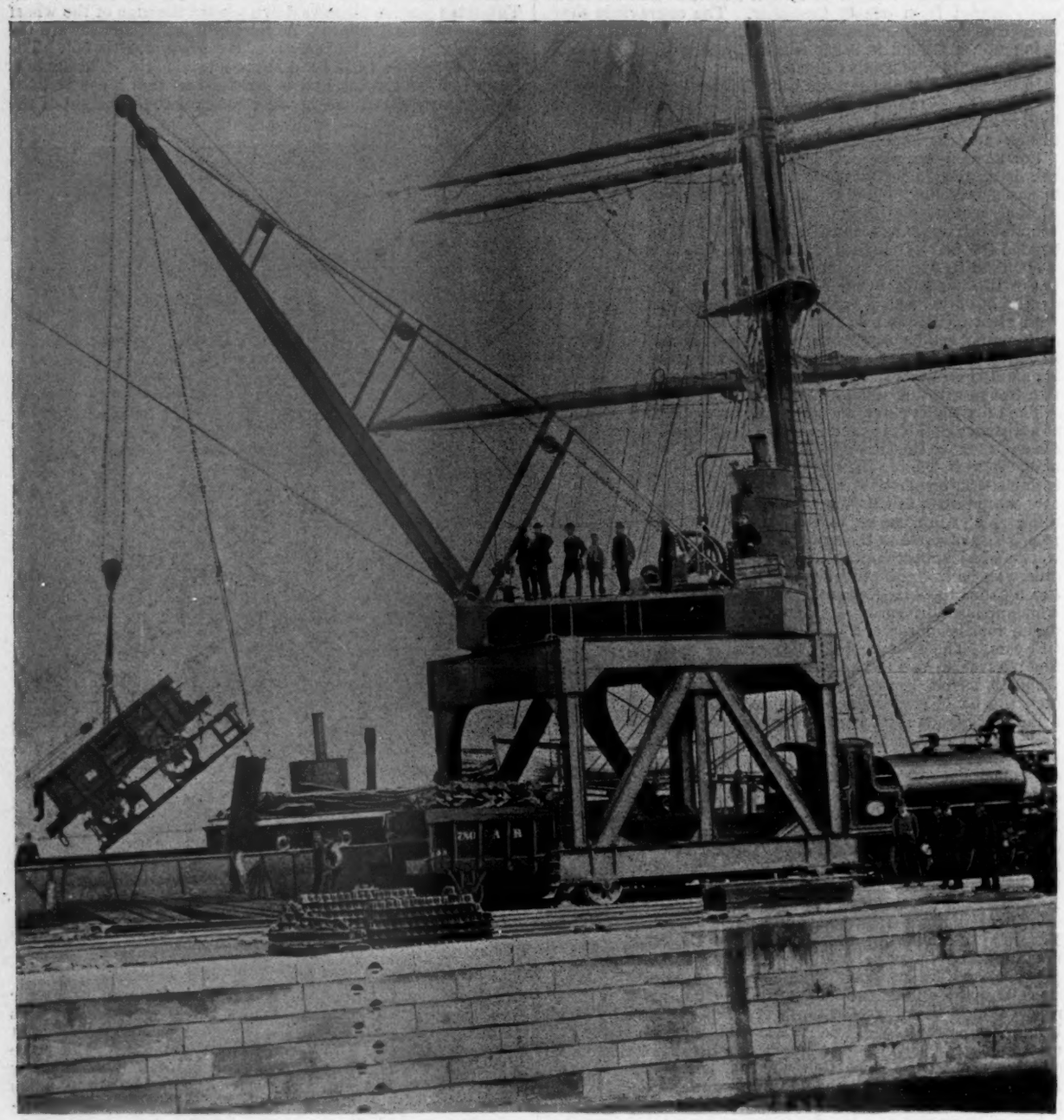


Fig. 4.

APPLEBY TRAVELING CRANE, JAMES WATT DOCK, GREENOCK, ENGLAND.

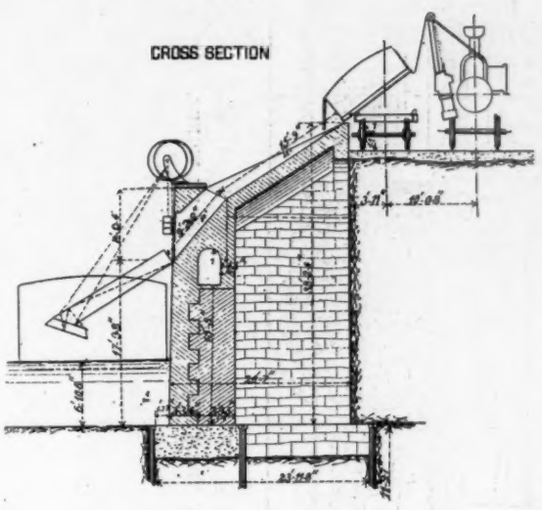
EXTRACTS OF THE REGULATIONS FOR THE USE OF THE COAL TIP AT ROTTERDAM.

The length of the cars, measured between ends of the buffers, must not be more than 28 ft. 10.5 in., and the outside projections on either side must not be more than 4 ft. 10.8 in. from the center of the track. The weight of the loaded cars must not be more than 39,690 lbs. The cars must be provided with an opening which is easily opened and runs their whole length. Cars which do not fulfil the above conditions cannot be run on the tip without special permission from the Superintendent.

The fee of $.05 per ton will be exacted for the use of the tip. This fee presupposes the delivery of the cars at a point indicated by the Superintendent or his subordinates and situated near the tip, the running of the cars on to the platform, the opening of the side doors, the tipping and replacing the emptied cars on a near by track. For emptying cars whose dimensions exceed those laid down in the above conditions, the Superintendent is empowered to increase the fee up to 50 per cent., according to circumstances. The charge for weighing a car on the scales of the track near by will be $.12 per ton of net weight with a minimum charge of $.73. The net weight is to be obtained by deducting as tare the weight marked on each car. A memorandum will be given on demand of the total weight thus handled. Detailed certificates of weight will be delivered to interested parties on the payment of a fee of $.02 per car with a minimum charge of $.24.

The commune assumes no responsibility for accuracy of weighing or certificates. The above fee includes the use of the crane belonging to the tip for evening off the ballast in a boat at the beginning of the loading, provided the ballast does not exceed 6 per cent. of the total quantity. The Superintendent is allowed at the request of interested parties to allow this maximum to be exceeded, but if this is done a supplementary charge of $.07 per ton will be charged for this work. If the crane is used in the handling of the coal it is at the risk of the interested parties. The minimum charge for the use of the tip is placed at $2.92. The fees shall be increased 30 per cent. for the use of the tip at night, and on Sundays and holidays the minimum charge will be exacted when the tip has been engaged but not used.

Fig. 5.



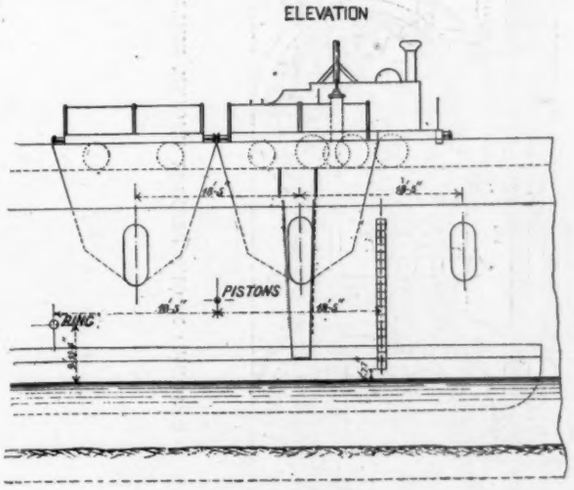
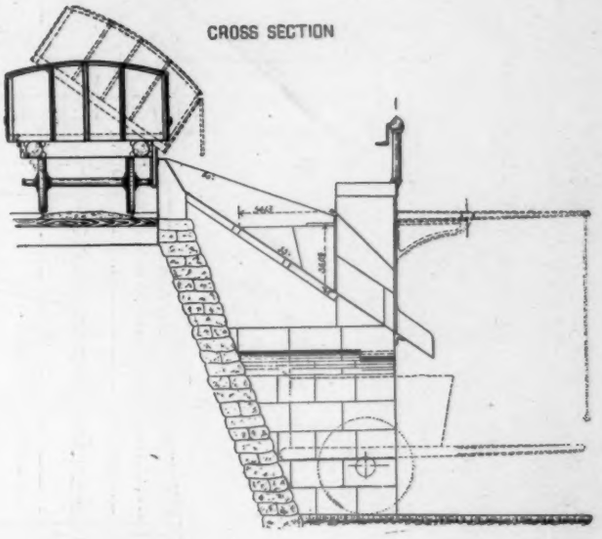


Fig. 6.

COMPOUND MOGUL FREIGHT ENGINE BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

Among the locomotive exhibits at the Chicago Exposition were five built by the Pittsburgh Locomotive Works, of Pittsburgh, Pa. One of them was a compound mogul, illustrations of which we give on the two following pages. The weight of the engine, which is 116,200 lbs. in working order, of which 100,500 lbs. is on the driving-wheels, is an exemplification of the tendency of modern construction toward the higher weights, in order to obtain the adhesion necessary for hauling the heavy trains which are demanded by the department of transportation.

Fig. 7.



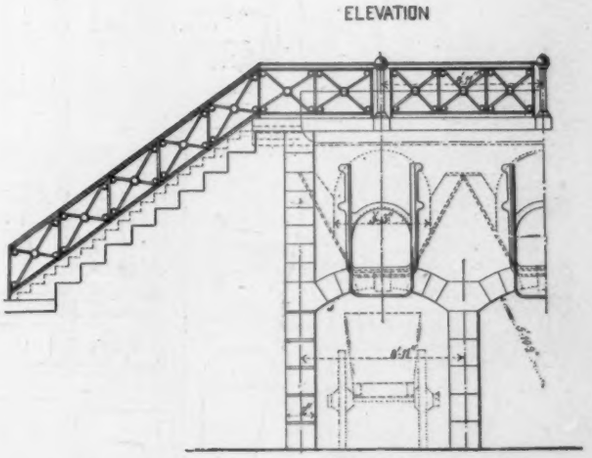
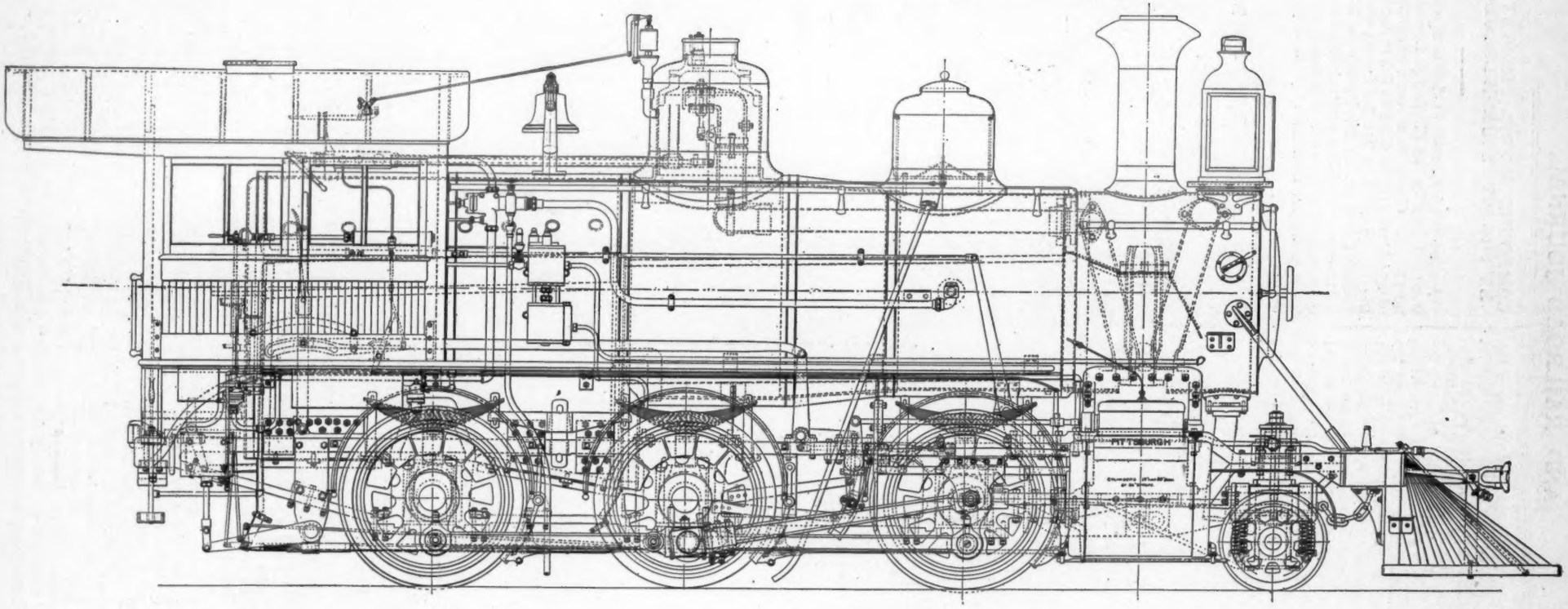


Fig. 8.

MECHANISMS OF THE SOCIÉTÉ CHARBONNIERE OF LENS.

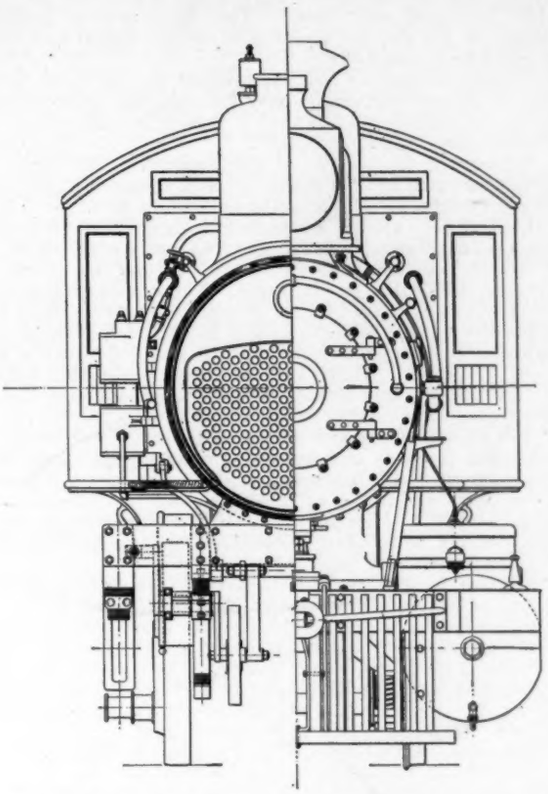
The engravings which we present give a front and rear elevation with a cross-section through the cylinders, and in a future issue we hope to be able to give a detailed illustration of the starting mechanism which is peculiar to these compounds. The diameter of the high-pressure cylinder is the same as that of the English and American locomotives which we have been illustrating in detail during the past year, and the stroke is the same as that of the English engine. In making a comparison between the details of the compound and that of the English engine, we find that the size of the high-pressure steam-ports is 1½ in. × 20 in., while those of the two engines to which reference has been made are 18 in. × 1½ in. for the American engine and 16 in. × 1⅛ in. for the English. But it must be remembered that we are here comparing a freight compound with two typical express engines, so that while the cylinder capacities are practically the same, the amount of



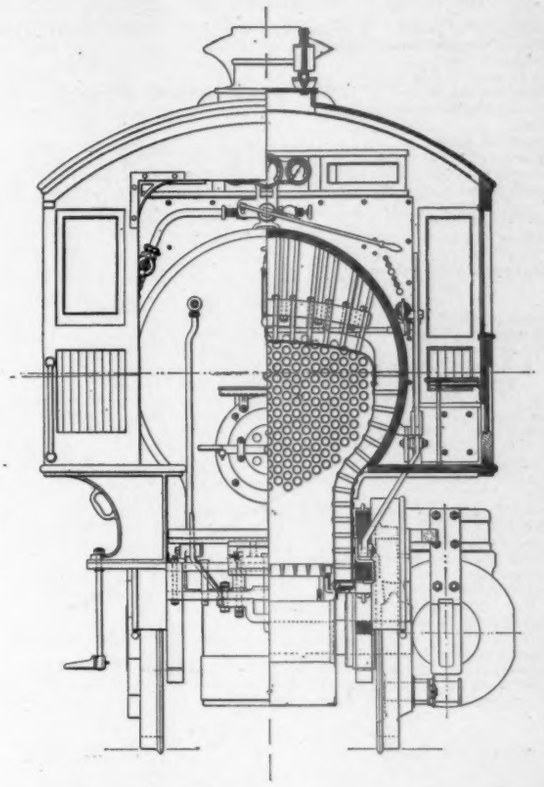
COMPOUND MOGUL FREIGHT ENGINE, BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

port opening which is given to the three engines under working conditions is very much less for the express engines than for the freight, while the weight of the freight engine is almost exactly an arithmetical mean between the two express engines. In the construction of the boilers the riveting of the English engine is quadruple for both longitudinal and circumferential seams; for the American express engine it is sextuple-riveted for the horizontal seams and double-riveted for the circumferential, and this latter is the type of riveting which is also used on the Pittsburgh freight. From 3½ in. to 4 in. may be taken as standard thicknesses of the water legs, although the English has but 3 in. at the front and back, while the American express engine has 3 in. at the sides and back.

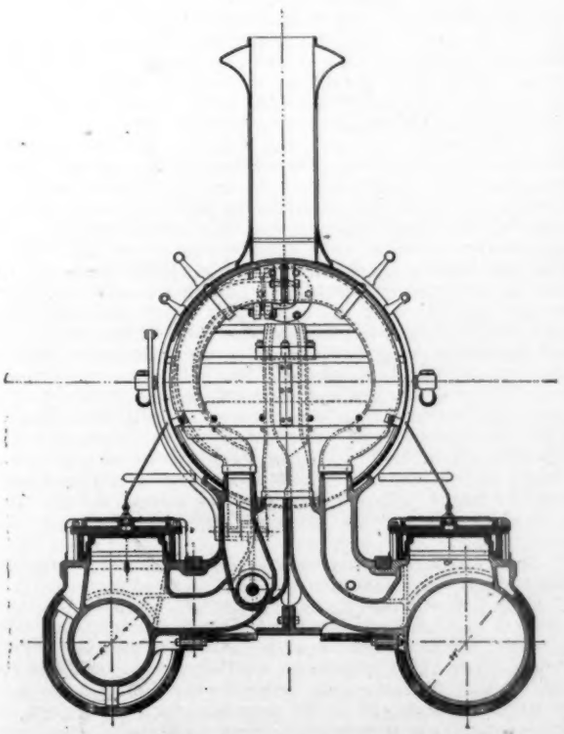
Regarding the details of the valve-motion, it is, of course,



FRONT ELEVATION AND SECTION OF SMOKE-BOX.



REAR ELEVATION AND SECTION THROUGH FIRE-BOX.



CROSS-SECTION THROUGH CYLINDERS.

useless and unprofitable to make a comparison, because the services for which the engines have been designed are so entirely different. The following is a list of the dimensions of the various details of the engine:

WEIGHT AND GENERAL DIMENSIONS.

Gauge of road	4′ 8½″
Actual total weight of locomotive in working order, including two men	116,200 lbs.
Total weight on driving-wheels	100,500 lbs.
" wheel-base	20′ 10″
Distance between front and back driving wheels	13′ 2″
" from center of main driving-wheels to center of cylinders	5½′ 4″
Length of main connecting-rod from center to center of journals	7′ $1\frac{15}{16}$″
Transverse distance from the center of one cylinder to the center of the other	7′ 4″

CYLINDERS, VALVES, ETC.

Diameter of L. P. cylinder and stroke of piston	29″ × 26″
" of H. P. " " " " "	19″ × 26″
Horizontal thickness of piston over piston-head and follower-plate	6″
Jerome metallic piston-packing	
Diameter of L. P. piston-rod	3½
" " H. P. " "	3½
Size of L. P. steam port	1½″ × 20″
" " H. P. " "	1¾″ × 18″
" " L. P. exhaust port	3″ × 20″
" " H. P. " "	2½″ × 18″
Greatest travel of L. P. slide valve	6″
" " " H. P. " "	5″
Outside lap of L. P slide valve	$\frac{15}{16}$″
" " " H. P. " "	$\frac{7}{8}$″
Inside clearance of L. P. slide valve	$\frac{5}{16}$″
" " " H. P. " "	$\frac{1}{4}$″
Lead of L. P. slide valve in full stroke	$\frac{3}{16}$″
" " " H. P. " " " "	$\frac{1}{16}$″
Throw of upper end of reverse lever from full gear forward to full gear backward, measured on the chord of the arc of its throw	4′ 3″

WHEELS, ETC.

Diameter of driving-wheels outside of tires	4′ 6″
" " truck-wheels	2′ 6″
Size of main driving-axle journal, diameter and length	8″ × 9″
" " other " " " " " "	8″ × 9″
" " truck-axle journals, diameter and length	5″ × 9″
" " main crank-pin journals, diameter and length	6″ × 5″
" " " coupling-rod journals, diameter and length	4¾″ × 6″
" " other " " " "	3⅛″ × 4½″
Length of driving springs from center to center of hangers.	3′ 1″

BOILER.

Description of boiler	Reduced shell.
Inside diameter of smallest boiler ring	4′ 10⅞″
Barrel of boiler	Steel.
Thickness of plates in barrel of boiler	5/16″ and ⅜″
Horizontal seams	Butt joint, double lap, sextuple-riveted.
Circumferential seams	Double-riveted.
Tubes	Iron.
Number of tubes	232
Diameter of tubes outside	2″
Distance between center of tubes	2¾″
Length of tubes over tube-plates	10″ and 10½
" " fire-box	9′
Width of fire-box	2′ 8⅜″
Depth of fire-box, front	6′
" " " back	5′
Water space side of fire-box	4″
" " back of fire-box	3½″
" " front of fire-box	4″
Outside shell of fire-box	Steel.
Thickness of plates of outside shell of fire-box	½″
Material of inside fire-box	Steel.
Thickness of plates inside of fire box	5/16″
" " " back end of fire-box	5/16″
" " crown plate	3/8″
Tube plates	Steel.
Thickness of front tube plates	½″
" " back " "	½″
Crown plate	Radial stayed.
Diameter of dome	2′ 6″
Height of dome	2′ 2″
Maximum working pressure per sq. in	15′
Grate	Rocking.
Width of bars over fingers	1′ 2″
Width of opening between bars	¾″
Grate surface	24.2 sq. ft.
Heating surface in fire-box	161 sq. ft.
" " of the inside of tubes	1,311 "
Total heating surface	1,472 "
Nozzle	Single blast.
Diameter of blast nozzle	5″
Smallest inside diameter of chimney	1′ 3¾″
Height from top of rails to top of chimney	14′ 7″
" " " " " center of boiler	7′ 7″

TENDER OR TANK.

Weight of tender, empty	28,800 lbs.
Number of wheels under tender	8
Diameter of tender wheels	2′ 7″
Size of journals of tender axles, diameter and length	4¼″ × 8″
Total wheel base of tender	15′ 9″
Distance from center to center of truck-wheels of tender	5′ 1″
Water capacity of tank (in gallons of 231 cu. in.)	3,600.
Coal capacity of tender or fuel bin	7 tons.

ENGINE AND TENDER.

Total wheel base of engine and tender	48′ 4″
" length of engine and tender over all	59′ 4¼″

COMPARISON OF ENGLISH AND AMERICAN LOCOMOTIVES IN THE ARGENTINE REPUBLIC.

THE following extracts are from a report made to the President of the Department of Engineers of the Argentine Republic by Juan J. Elordi, Mechanical Inspector :

"In compliance with the President's mandate we take pleasure in making our report respecting the reasons which have caused this department to affirm that the rolling stock of the Southern Railway is not suitable for the service intended.

"To enable us to expose the defects more clearly, we have found it necessary to make a comparative study of this and the rolling stock from the United States, owned by the Western Railway, which was acquired when this enterprise was the property of the State.

"All the rolling stock of the Southern Railway was manufactured in England. As regards quality of material and its strength, it is all that could be desired ; but the builders did not take into account the character of road-bed and track on which it was to run, and, therefore, made it too heavy and the wheel base too rigid.

"The locomotives might run well enough on European roads, which are substantially built and well ballasted ; but such is not the case in this province, where most of the railways are built on loose soil, especially those of this company, and subject to frequent inundations.

"The result is a large increase in the cost of maintenance of way and repairs to rolling stock, and consequently a heavier burden on the income of the road and a proportionate reduction of interest on capital.

* * * * * * *

"*Class* 5.—These locomotives were intended for the express trains running between Buenos Ayres and Mar del Plata, but the results of their trial trips were so unsatisfactory that the Company was compelled to use them for ordinary passenger service. . . . They have a single driving axle (Crampton system), and the adhesive weight upon it is 29,392 lbs., or 14,696 lbs. upon each wheel. This, even with a working pressure of 160 lbs. per square inch, is insufficient to obtain the adequate tractive power.

"Practical experience has demonstrated that the locomotives built for this service should have two coupled axles, and an average weight of not less than 8 tons upon each wheel, to afford adequate tractive power. . . .

"Examining the weight of the locomotive, the unequal distribution upon each axle will be noticed, and the effects of this will be noticeably injurious to the permanent way. . . .

"*Class* 6.—Of all the locomotives owned by the Company these are the most suitable for the road, but even these show the weight imperfectly distributed, there being an excess of more than 10,373 lbs. on the bogie. The system of supports is inferior. While the absence of equalization permits of replacing the springs more readily, it has the disadvantage of making it impossible to distribute the shock due to the inequalities of track. They have, moreover, a swing-bar which connects the two fore-springs—a system that has been abandoned owing to its inefficiency.

"The excessive pressure at which the boilers are worked necessitates frequent and important repairs, such as the renewal of most of the tubes and stacks. The tube-plates and the fire-boxes are destroyed in a short time, notwithstanding the good quality of the material, owing to the high pressure of 160 lbs. per square inch, although higher pressure should be admissible without doing injury.

"All this is well proven by the cost of repairs, which amounts in two years to the sum of $1,800 gold.

"*Compound Class.*—It is evident that this system of locomotives for passenger trains was adopted without proper consideration of the conditions of service. Their greater weight, as compared with the high-pressure locomotives, the repairs required by them, the qualifications of the men who were to run them, should have been taken into account. . . .

"How small the economy of fuel realized in these over the consumption of the high-pressure locomotives may be seen by comparing the consumption of the latter with that of the locomotives of the Class 6.

"The distribution of weight of this type is also very unequal, making a difference of over 13,466 lbs. in excess upon the bogie—a very notable excess, since the average weight per square centimeter of surface of the road is 638 lbs.

"The pressure required in the boilers of these locomotives is 175 lbs. per square inch, this being necessary to obtain useful work ; but this has the inconvenience of necessitating continuous and serious repairs to the boiler. The journal-boxes are repaired and replaced very frequently owing, to the rigidity of the springs, and, as if this were not enough, the cylinders are very easily striated, according to the engineers of the Company, by the heavy weight of the piston, but due, in our opinion, to a blunder of construction which prevents the stem or rod of the piston from keeping its center in relation to the axis of the cylinder. The intercepting valve with which these locomotives are fitted and which helps them to start with the low-pressure cylinder in case the piston of the high-pressure cylinder is at the dead point, must work automatically—that is to say, it must put the boiler in communication with the low-pressure cylinder when the locomotive stops by means of a small auxiliary pipe. But it happens that it never works with regularity, and we have noticed in many cases that it requires from 8 to 10 minutes to start the train, having to back or reverse in order to effect this, a circumstance which generally causes the breaking of the traction hooks and bars, without taking into account the annoyance to the passengers from the heavy jerks, or the delays occasioned by the time required to take out the damaged vehicles and transfer the passengers. . . .

"These locomotives can only be examined from the standpoint of their weight and the bad distribution of same. . . .

"*Class* 7, *Compound A.*—These locomotives have the same defects as those of Class 6, but in the consumption of fuel they are worse. The distribution of the load over the axles is very unequal, there being in this case a difference of over 7,508 lbs. more on the bogie, the load being the heavier, as it has only one axle. In these, as in the previous ones, the repairs are very expensive, as may be seen from the detailed data given above.

CARS.

"Most of the cars of the Southern Railway have three axles and are very heavy, especially the sleeping-cars, which have a dead weight of 3,113 lbs. per passenger. The last cars recently placed in service consist of two classes of parlor cars, having each four axles on two bogies; but these are also very heavy compared with the American cars. . . .

"The passenger vehicles acquired might form a museum, such is the assortment of different models, only the difference in their outlines among the most modern being very remarkable. The first-class parlor cars (Class L 1) lately arrived have very narrow lateral doors, are very heavy, and in the interior decorations there is a censurable profusion of mirrors, which will be easily broken or scratched, thus requiring frequent renewals. It would have been more dignified and economical to have used veneered wood in their stead.

"The sleeping cars (Class F 4), besides being heavy, have an unpleasant movement, and if to this the bad condition of the road is added, we can easily imagine the annoyance to the passengers. The beds or berths are very narrow, and with the heavy jerks of the car it is almost impossible to remain in them.

"The seats in the second class cars (Class L 3) are not in accordance with the provisions of Article 58 of the 'Decreto Reglamentario' of the Railway Law, which provides that each passenger should be furnished with a seat 19½ in. wide in front and 15¾ in. deep. Instead of this a seat is placed on one side for three passengers, measuring only 54¾ in. in front, and another on the other side for two passengers measuring 35¾ in. in front. . . .

SLEEPING-CARS.

"The President has been able to appreciate correctly the good conditions of these cars as regards their running and the comforts they offer; however, it would be advisable to indicate to the Company how advantageous it would be to give to the beds of the large compartment the whole width of the seat (1 meter), as those of the American cars; it would be also desirable to suppress the lavatory at the end of the car, and to leave only the water-closet, adding to it a urinal, and arrange the doors so that they should not make, as they do now, that noise which is so annoying to the passengers. For the rest we find the reform highly practical, and it shows a perfectly well-finished work.

"The idea of reforming the three-axle sleeping cars so as to make one car out of every two cars, by erecting or supporting it on bogies, deserves the full approbation of this section, saving the little defects mentioned in the preceding paragraph.

AMERICAN ROLLING STOCK.

"The American rolling stock is much more suitable for our roads, because of the similarity in the construction and the nature of the ground of the United States and our country, and because of its simplicity, reduced weight, and improved system of equalization. Moreover, it costs less, and necessitates much less expense for keeping it in repair than the European stock.

"The American locomotives owned by the Western Railway, which were acquired when this road was the property of the State, by the engineers Messrs. Miguel Tedin and Louis Rapelli, are 10 for rapid trains, eight for freight trains, and 12 for switching, and were built at the Baldwin Locomotive Works, of Philadelphia, in 1889. The same works built in 1884, 30 locomotives for mixed trains for the railway of this province.

"The construction of these 60 locomotives, notwithstanding their simplicity, is first class, except in a few small details, which by no means affect their good conditions for service. The 30 locomotives for mixed trains have withstood very severe tests during the period when the railway had not the number necessary for its service, as, notwithstanding the excessive amount of work imposed upon them, the results have been very satisfactory and economical.

AMERICAN LOCOMOTIVES.

"*Class* 11.—(By the Baldwin Locomotive Works, 1884.)—It would suffice to compare the above data [not given here] with those of the Southern Railway locomotives to realize the superiority of these locomotives as regards the good distribution of the weight, cost of engine, and cost of repairs.

"The repairs they require are inconsiderable; their boilers continue in perfectly good condition, and in nine years' service it has been only necessary to renew the tubes of 15 locomotives, the fire-boxes and the tube and boiler-plates being in good condition. The system of equalization is superior, having equalized levers to connect the springs on each side, and the results have been good, even at a time when the road was in a bad condition.

* * * * * * *

"*Class* 14.—(By the Baldwin Locomotive Works, 1889.)—In tractive power the American locomotives are first-class, and with trains composed of 25 parlor cars they have developed a speed of 50 to 60 kilometers an hour, and a higher speed could have been attained, had it been desired and had the state of the road permitted. The distribution of the weight over the axles is even in all, and this is one of the good features combined in them. So far their boilers, during their three years' service, continue in a perfect state of preservation. The repairs they have to undergo are inconsiderable and confined only to the renewal of the bearings and the turning of the tires.

"*Class* 15.—(By the Baldwin Locomotive Works, 1889.)—These locomotives, like the preceding, are very good; their work and preservation are unsurpassed in good results. The weight on the axles is also even in all of them, this being one of their best features for our roads.

"It may be concluded, from all the data furnished in this report, that the Southern Railway locomotives are but iron masses, entirely injurious to the roads and interests of the Company, and that a large part of its rolling stock is unnecessary for the service of its lines, as neither the condition of its road nor the necessities of its traffic require it. . . .

"So unfavorable has been the result of the compound locomotives (Class 6 A) that it was necessary to withdraw them from the Mar del Plata service last summer, and to use in their place the freight locomotives, owing to the tractive power of the former being less than was required. We think that the foregoing report is sufficiently specific to enlighten the President, and to justify us in asking him to decree that no company be allowed in future to import in this country their locomotives without first presenting and submitting their plans to the approbation of this Department.

CARS.

"It will suffice to cite the principal features of the American cars to establish their superiority over those built in England. As the outside of the former is all made of first-class white pine, their cost is reduced without sacrificing their strength, and they are made lighter thereby."

[Here follows a description giving the weights, capacity, number of axles, and cost of the different classes of American cars, which is not reprinted.]

"The preservation of this rolling stock is very economical, and they are now in perfect condition after four years' service. The dead weight per passenger is one-half less than that of the English cars, excepting the sleeping-cars, in which the difference is only of 913 lbs., having four axles instead of three, as the others have. The system of bogies is the best for our roads, because having no lateral movement they do not injure the road; whereas those having three axles require said movement to run over the curves.

"Trusting that we have fulfilled the task imposed upon us to the satisfaction of the President, we respectfully salute him.

(Signed) "JUAN J. ELORDI,
"*Mechanical Inspector.*
"FCO. ESTEVES,
"*General Sub-Inspector.*"

Of the above it may be said that the English builders of the locomotives and cars *could* have made machines and vehicles better adapted to the requirements of the roads in the Argentine Republic, but the fact that they did not do so seems to be abundantly shown by the above report. The fact is that the requirements of our American railroads have resulted, quite naturally, in the evolution of a system of rolling stock adapted to their environment. The conditions existing in the Argentine Republic and other parts of South America resemble much more nearly those which prevail here than those which exist in England, therefore quite naturally our locomotives are better suited to the roads in that continent and other new countries than the English machines are without modifications. It has been said that doubtless the Lord could have made a better berry than the strawberry had He chosen to do so, but apparently He did not so choose, and therefore the strawberry maintains its pre-eminence. So it may be said that the English builders of the Argentinian locomotives and cars might—perhaps—have made better machines than they sent to that republic, but apparently they did not choose, or did not know how to do so, and therefore the united scream of the American locomotive and the American eagle has again silenced the growl of the British lion in our sister republic of South America. Hip, Hip —— !—EDITOR AMERICAN ENGINEER.

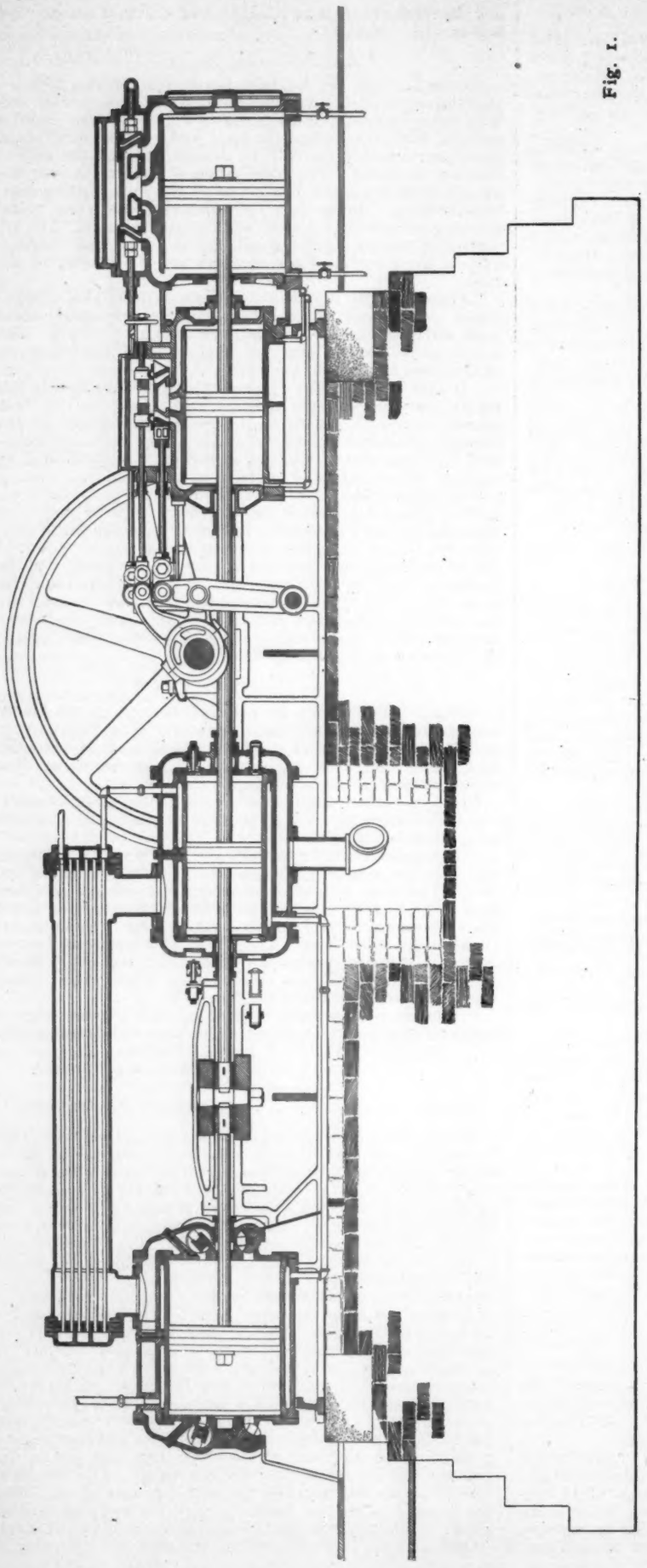


Fig. 1.

COMPOUND AIR COMPRESSOR, BUILT BY THE SOUTH NORWALK IRON WORKS.

THE NORWALK COMPOUND AIR COMPRESSOR.

In our recent issues we have been publishing illustrations of several types of hydraulic and pneumatic hoists for machine shop use. On another page of this issue we publish an illustrated description of the pneumatic hoisting arrangements that are in use in the New Haven shops of the New York, New Haven & Hartford Railroad. The use of compressed air is meeting with a wider and wider application every year, and its utilization as means of transmission of power has been widely applied in Paris, and it is probable that the same means will be used at some of the plants at Niagara Falls. As the pump is a necessity for hydraulic work, so the air compressor is the basis from which this pneumatic work must start. The compressor which we illustrate is one of the standard type which is built by the South Norwalk Iron Works, of South Norwalk, Conn., and presents some novel and interesting features. In the construction of this compressor the objects aimed at were to make the resistance of the air to compression an average resistance throughout the stroke instead of being a maximum and excessive resistance at the end; to reduce the losses and clearance spaces to the smallest possible amount by having the pressure in the intake cylinder a light one, and finally to have the advantages of two water jackets and more time for cooling the air. After the introduction of the compound compressor, in which the larger cylinder compresses air into the small one, the next change in the development of the construction was the addition of an intercooler between these cylinders, which is shown in section in the engraving as connecting the two cylinders. This intercooler consists of a large pipe reservoir filled with thin brass water pipes. As the air passes to the second cylinder it becomes divided into thin streams by these pipes, and thus every portion of it is brought into close and immediate contact with the cold surfaces of the pipes, and the temperature is very rapidly reduced. In addition to the advantages which were obtained from the mere cooling of the air and the consequent avoidance of the excessive temperature resulting from compression, it was found that this intercooling between the cylinders produced economic results which were somewhat unexpected. The reason for the economy obtained is that when compression takes place in the large cylinder the air is heated, and if this were allowed to pass directly to the compression cylinder it would fill it with air at a given temperature and volume. Therefore, if this temperature is reduced the actual volume of air introduced into the second cylinder would be increased and the capacity of the machine correspondingly augmented.

Up to the time of the development of this machine we believe that all of the inlet valves were of the poppet type. The change was made by first introducing a Corliss valve for the inlet valve. These valves were opened and shut in connection with the main engine, and no vacuum was required in the air compressor to insure their working. The next step was in making a direct valve connection between a return crank on the engine and the valves, and also making a direct connection between the openings of these valves and a conduit which came in beneath the floor from the outside atmosphere, so that air which was naturally as cool as possible was introduced into the first cylinder,

thereby avoiding the extra temperature which would naturally arise when air is taken from the engine room. This change alone is said to have secured a saving of about 1 per cent. for every 5° lower temperature obtained. The

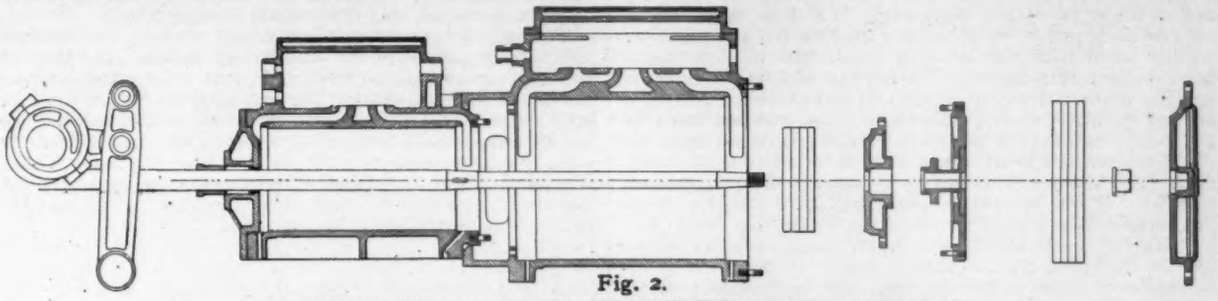


Fig. 2.

SECTION OF STEAM CYLINDERS—ARRANGEMENT OF STEAM CYLINDERS.

Corliss inlet valves having been such a success they were next introduced as delivery valves for the low-pressure cylinder, as shown in the longitudinal engraving which we present. While the pressure which is delivered from the low-pressure cylinder (being only about 25 lbs.) is so light that its effect on

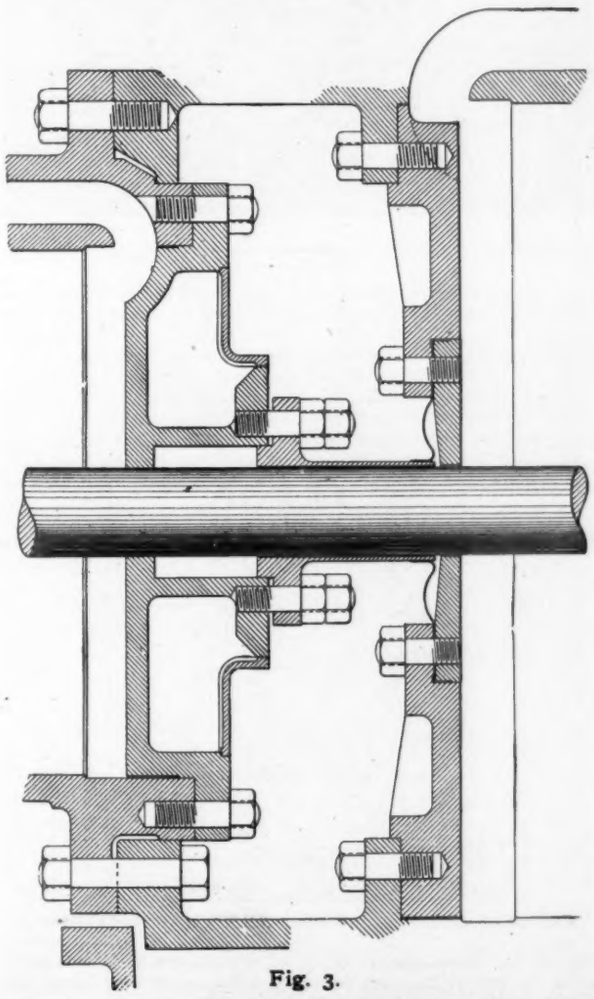


Fig. 3.

INTERMEDIATE PACKING-BOX FOR STEAM CYLINDERS, SOUTH NORWALK AIR COMPRESSOR.

the wearing of the Corliss valve was considered of little consequence, no change was made in its construction; but when there came a demand for compressors delivering pressures up to thousands of pounds to the square inch, it became necessary to use a higher pressure in the inlet cylinder. The valves are therefore now moved by cams, the shape of which are such that the valve remains at rest until the pressure below it is nearly equal to that above it. Then the movement commences, and the valve is quickly forced wide open. In closing, the cam gives a rapid movement, so that the valve is seated before any considerable pressure comes upon it. The connection that throws it shut is elastic, so that if a valve becomes dry it does not cut. The ordinary poppet valves are objectionable when used for inlet valves, because in order to insure a prompt action when the valves become sticky with gum, oil, or other substances, it is necessary that the springs should have a force of not less than 8 oz. per square inch; and while this has but little effect upon a pressure working at the sea-shore, at high altitudes it is a very considerable detriment; and also, though the vacuum may be inappreciable when measured by the ordinary vacuum spring, it is considerable when 4 lb. springs are used, and may amount to as much as nearly 3½ per cent.

To quote the ideas from the Norwalk Company's catalogue, the ideal compressor, in order that the work may be constant, should have a conical cylinder, so that the light pressure exerted upon a large piston at the beginning of the stroke would be equal to the heavy pressure exerted upon a small piston at the end of a stroke. This is practically impossible to construct at present, and the compound cylinder, as now built, affords as near an approach to this as is possible to obtain. In order that the application of power may be uniform during the whole stroke, the pistons and cross-heads of all four cylinders are connected to one rod; and as these parts have considerable weight, which requires most of the power of the steam over and above the air resistance at the beginning of the stroke to start them forward, so, at the end of the stroke, when the steam pressure is weak and the air pressure high, the power stored in the momentum in these reciprocating parts is given out in useful work, and the parts are brought to rest by expending their force in compressing air. As the energy thus stored depends on the weight of the reciprocating parts and on the square of the number of revolutions, it is evident that rotating speed is a very important factor to take into consideration. Therefore short strokes are used. The use of the fly-wheel is merely to regulate the steam-valve motions and to control the length of the stroke and even up and balance any inequalities which may result from the relations of power to resistance and secure a uniform speed for the machine. Surface condensing is used entirely, and no water is allowed in the cylinder. The advantages of surface cooling in comparison with that of water in the air cylinder are several. The first consideration is that the compression with surface cooling is dry. This is an important matter, for when air is heated by compression and brought into contact with the water, it is apt to become saturated with moisture. It is well-known that when air is exhausted after doing its work, it is apt to have a temperature far below zero, so that it quickly freezes all moisture in the air and deposits it as ice in the exhaust passages of the air engine, which will therefore become quickly closed. The natural remedy is, of course, to keep the air cool. It is estimated that if 100 H.P. were required to deliver a certain amount of air at 60 lbs. pressure without having any cooling apparatus connected therewith at all, a saving of 21.6 per cent. would be made if a perfect cooling apparatus could be added to the compressor.

There are one or two details in regard to the construction of this compressor which are exceedingly interesting. The longitudinal skeleton section which we give of the machine, fig. 2, shows the general arrangement of the steam cylinders. The great difficulty which is ordinarily experienced with a tandem compound steam engine is that, when it becomes necessary to remove the piston-head of the forward cylinder, it is necessary to take out everything behind it, and when the heads are so arranged that they cannot be readily removed, it is frequently necessary to back off the rear cylinder and separate it from the machine. When this is not done it is frequently necessary to uncouple the piston-rod from all its connections and back that out in order that the heads may be removed. The compound cylinders which we illustrate here are made tandem with the

high-pressure cylinder toward the center of the piston-rod. The low-pressure cylinder comes up close against it, and the flanges, cast on the cylinder itself, bolt against flanges on the high-pressure cylinder. The heads are put in from the rear end of the low-pressure cylinder, and they are shown in section at the right of the engraving. It will be seen that the high-pressure piston can be slipped over the rod and the latter backed down until the key-way comes near the open space between the two cylinders. The key can then be driven home and the piston rod adjusted without any trouble. Next the head of the high-pressure cylinder is slipped into position over the rod through the low-pressure cylinder and bolted upon the studs, the wrench being easily worked in between the cylinders. The next step is to put in the head of the low-pressure cylinder. It will be seen that this, instead of flanging up on the outside, is bolted to an internally projecting flange and comes up on the inside of the cylinder, being cut away on the top for the steam port, so that it does not interfere with the admission of steam in the slightest. The low-pressure piston is then put on and held with a nut, as shown, and finally the back-head is bolted on the same like any ordinary cylinder-head.

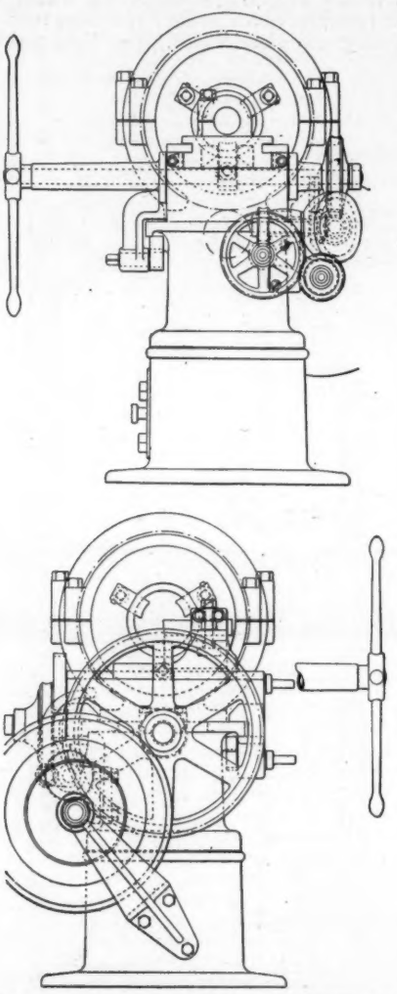
Another novel and exceedingly interesting detail of these cylinders is the construction of the packing-box between the two cylinders. This is also shown in detail in our engraving, fig. 3. Every engineer who has had to do with tandem compound engines knows the difficulty of packing and keeping packing tight in the stuffing-boxes between these two cylinders; and designers are well aware of the difficulties which constantly confront them of shortening the total length over all of tandem compound cylinders, and still have sufficient room between the cylinders for the stuffing-boxes and the proper handling of the same. Some have even gone so far as to use a head with a corrugated piston-rod without any stuffing-box whatever; but the construction of the Norwalk engine is certainly unique and worthy of careful attention. It will be seen, from an examination of the engraving, that there is but one stuffing-box, and that on the head of the high-pressure cylinder. This stuffing-box is of the ordinary type, and carries a metallic packing which can be easily adjusted with a very slight motion of the gland. The gland is bored out so as to fit the piston-rod snugly, and extends back to a point close to the low-pressure cylinder head. It is there connected by a copper plate, as shown, which comes up against the head and is held by a clip as shown. It is firmly attached to the gland. This has strength enough to resist the steam pressure existing in the low-pressure cylinder, and yet has the flexibility enough to allow the gland of the high-pressure stuffing-box to be moved backward and forward all that will be required for ordinary adjustments. It will thus be seen that the packing on the high-pressure stuffing-box is subjected to two pressures. The low-pressure cylinder pressure runs beneath the gland and works on the outside, while the high-pressure steam follows the piston-rod between the head and comes against the packing on the inside, the latter separating the two and effecting a perfectly tight joint.

The other details of the engine which are attached to these standard compressors are so designed as to attain the highest economy possible. The steam cut-off valves have a wide range and are quick in their action, giving a clear point of cut off and a very perfect expansion line. The cut off is changed by turning a hand-wheel placed at the back end of the high-pressure steam-chest, and it is easily accessible. The point of cut off can be changed while the machine is in motion to meet any requirements of speed. Its position is shown by an index, and the experience which has been gained in the construction of these compressors show that the engine is particularly well suited for the duty which it is called upon to perform.

PROJECTILE TRIMMING MACHINE.

We illustrate a projectile trimming machine, which has been built by the Bridgeport Machine Tool Works, of Bridgeport, Conn., for the United States Projectile Company, of Brooklyn, N. Y. The tool is made especially heavy, and is intended for trimming off the ends of shells after they have been taken from the presses in which they have been formed. The principal and prominent feature of the machine is the chuck, which stands near the center of the bed. This chuck is driven by a gear-wheel meshing in with a pinion that is keyed to the main shaft, which runs along the length of the machine in the center of the bed. The teeth run close to the casing, and there is a short bearing on the outside of the same. In order to save end room and to be able to bring the edge of the cutting tool close up to the chuck, the dogs for holding and centering the shell are set into the face of the chuck. These are of the independent type, and are set for each size of shell. When it is necessary to remove the shell, one is slackened off, the shell removed and another slipped into place, when it is again tightened down. They are, as we have already said, flush with the face of the chuck, so that they are out of the way while work is being done.

The machine is driven by a 4 in. belt running over a three-step cone at the end of the machine, as shown. The shaft of the cone carries a pinion meshing in with a large spur-gear on the end of the main shaft. The tool-posts are carried by extra strong and heavy carriages with cross-feeds. The end carriage has an arrangement for holding a boring-bar that is used for turning out the inside of shell, so that when the latter is once in position it can be finished without being removed from the machine. The feed-rod runs along the back of the machine and carries worm-gears for operating each carriage. The chuck is geared 19 to 1 with the cone shaft, and the revolutions of the chuck may be varied from 12 to 50 per minute with four intermediates—namely, 16, 21, 28, and 37. The cross-feed is .01 in. per revolution, and the boring-bar feed is the same. It will be seen from the engraving that the bed is exceedingly strong, and that all parts are so proportioned that they are capable of doing the heaviest work. This is merely one of the many special types of machines which have been built by the Bridgeport firm for doing particular kinds of work.



END ELEVATIONS OF PROJECTILE TRIMMING MACHINE.

MEETING OF MEMBERS OF THE SOCIETY OF MECHANICAL ENGINEERS.

Some of our readers will remember an editorial article which was published in The American Engineer of last September, with the title "Monthly Meetings of Mechanical Engineers for Technical Discussion." This article was afterward reprinted on slips, with a note appended, asking members of the Society "who feel an interest in the scheme of

holding such monthly meetings for the discussion of technical subjects as were suggested in the article to signify their approval or disapproval of it by communicating with the editor of THE AMERICAN ENGINEER." A copy was then sent to each member of the Society. About 50 replies were received, all approving of the scheme proposed. As a sequel to this a meeting of a few of the members of the Society was called, and met in its hall on November 1, and the following resolutions were adopted:

"*Resolved*, That it is the sense of this meeting that it would be desirable and profitable that an opportunity be given for members of the American Society of Mechanical Engineers to meet at convenient times during the coming winter and spring for the discussion of subjects pertaining to Mechanical Engineering.

"It is further resolved that a committee of five be appointed to arrange for such a series of monthly meetings during the coming winter and following spring, that it be authorized to select and appoint a chairman to preside, to fix dates for holding, and to issue calls for such meetings, select subjects for consideration and speakers to present and discuss them, arrange the order of proceedings and make all necessary rules for the conduct of such meetings, solicit subscriptions and audit and pay all bills incurred for such expenses and fill vacancies which may occur during the period named."

PROJECTILE TRIMMING MACHINE, BUILT BY THE BRIDGEPORT MACHINE TOOL WORKS.

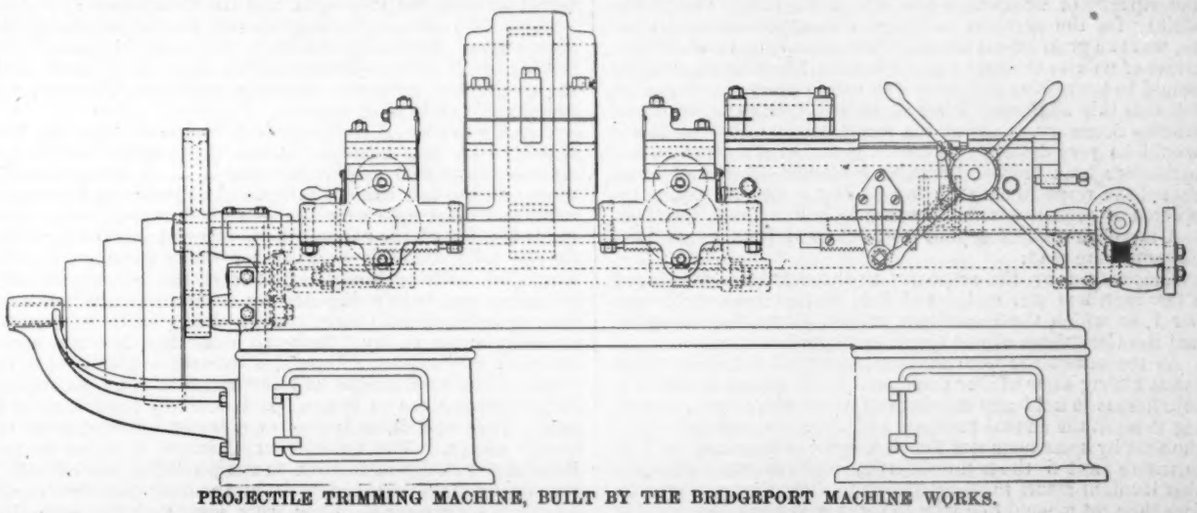
The Chairman of the meeting, Mr. M. N. Forney, was made permanent chairman of the above Committee, and he was authorized to appoint four other members to act with him. Commodore C. H. Loring, Mr. C. W. Hunt, and Frank Ball were appointed to act with the Chairman, leaving still one vacancy. After deliberating on the subject submitted to their consideration the Committee issued the following call for a meeting:

To Members of the American Society of Mechanical Engineers.

"In accordance with the duty delegated to them the Committee have selected the evening of the second Wednesday of each month as the time and date for holding such meetings. The first one will be held on Wednesday evening, January 10, at 8 P.M. The subject which will be considered will be the Development of Stationary Engines as illustrated by those exhibited at the Columbian Exhibition in Chicago. Mr. F. F. Hemenway, editor of *The American Machinist*, who spent considerable time at the Exhibition, will give a short talk—not a formal paper—on the subject, which will not exceed 30 minutes in length, after which the subject will be open to general discussion, the speakers to be limited to five minutes' time, and none to speak more than twice, until all who wish to do so have spoken. Builders of stationary engines are especially invited to take part in the discussion, and if the Chairman of the Committee is advised before the meeting of their intention to do so, time and places after the opening talk will be assigned to them. Such persons are also invited to send photographs, drawings, or models illustrating interesting features or recent forms of construction of stationary engines, for examination by those in attendance.

"It was agreed by the Committee that all members of the Society may have the privilege of introducing or bringing friends to the meetings, who may with the consent of the Chairman take part in the discussions. It is hoped that the proceedings will prove to be of sufficient interest to strangers so that mechanical engineers of distinction visiting in New York will always be brought and introduced at these meetings.

"It is expected that Mr. C. W. Hunt will preside on the evening of January 10. As this first meeting will, to a very great extent, be an experiment, it is very desirable that it should be successful. Members in sympathy with the movement are therefore earnestly invited to be present, and to do or say something which will add to the interest of the proceedings."



PROJECTILE TRIMMING MACHINE, BUILT BY THE BRIDGEPORT MACHINE WORKS.

In response to this call about 50 members assembled in the hall. The meeting was called to order by the Chairman of the Committee, who then said:

Members of the Society of Mechanical Engineers:

In opening this meeting perhaps a few introductory words are needed, and as in presenting a stranger to a friend we usually say a word or two to make the antecedents and origin of the stranger known, so it may, perhaps, be expected that

those to whom the duty has been delegated of inaugurating these meetings will say something of their origin and purpose. To some of us it has seemed very desirable that more frequent opportunities should be given to the members of this Society of coming together, for the consideration and discussion of subjects in which we are all interested, than the regular meetings of the Society provide. During the past few years some effort in this direction has been made, which gave those of us who were interested in the movement sufficient encouragement to make another effort in this direction. To explain why those meetings which were held at irregular intervals were not continued, it may be said that what may be called the installation of such meetings is not as simple and easy as those persons who have never undertaken it are apt to think. The difficulties and labor involved in preparing for such conferences are very considerable In holding a meeting at which there will be interesting discussions there must, in the first place, be some subjects to discuss. Without such subjects the meetings will be flat, stale, and unprofitable. Now not every topic that can be thought of will be productive of discussion. If the members were invited to come here and ponder over the intensity of pressure per square inch exerted by locomotive driving-wheels on rails, probably it would not stimulate much talk, because very little is known of that particular subject. To have a good meeting you must have a good subject, and this implies that some one must use his knowledge, refer to his experience, and exercise his wits to select one which will be prolific of discussion. Having done this, there must be some one to talk about it. Now those of us who have had experience in what may be called the dynamics of meetings have found that there is a great deal of inertia in men's minds, and that generally some stimulus must be provided which will make them think and talk. If you bring a body of men together and ask them to make remarks on an abstruse subject, without first giving them some stimulus—I do not refer to the liquid form—you may have a sort of Quaker meeting as the result. There must usually first be something to excite the minds and the tongues of those in attendance. Not only a subject must be selected, but one or more speakers must be provided, a chairman must preside who will call out the timid and suppress the wind bags, rules must be made, notices sent out, and many other details attended to. At previous meetings which were held no adequate provision was made for this kind of supervision. The members of this Society have learned to depend upon their Secretary to such an extent that they are apt to think that any duty may properly be imposed on his shoulders. It will not be out of place here to say that the general supervision of a series of meetings, such as are now contemplated, is not distinctly the duty of the Secretary, and ought not to be imposed on his shoulders and added to his other multifarious tasks. If any of you have ever acted in the capacity of a Secretary you will realize this. The responsibility for the previous meetings, which have been referred to, was to a great extent placed almost entirely on his shoulders. Some of us who thought that a continuation of those meetings would be interesting and profitable and in every way desirable, felt that this additional labor ought not to be expected of our worthy Secretary, while at the same time we also felt that it would be very desirable to continue the meetings which had heretofore been held at irregular intervals. A few of us assumed the responsibility of first issuing a circular asking the opinion of members with reference to holding such meetings.

A large number of replies were received from which some extracts were read.

Encouraged by the responses to the circular, a meeting of a few members was called and held in this room on November 1, at which the resolutions printed above were adopted, and the Committee named above was appointed.

At the outset the Committee encountered a feeling which exists among some of our members, which is that it would be injudicious to hold any meetings of the Society itself, excepting those at the annual meeting and annual convention. It is thought by some members that if a series of meetings are held in which most of the non-resident members cannot participate that it might result in dissatisfaction. The Committee therefore thought it would be wise to make a distinct disavowal of any intention of holding regular meetings of the Society. This was done in the following paragraph of their circular:

"In order to avoid misapprehension the Committee deem it best to explain that the meetings which it is proposed to hold will not be, in any sense, meetings of the Society, but only of such members as may choose to attend them. The proceedings will form no part of the transactions of the Society, and will not be published by it. The members who come to the meetings will merely be exercising their privilege of assembling in the Society's hall and discussing subjects of mutual interest."

The general idea which the Committee have had in mind was first to select some subject for consideration which would be likely to elicit discussion. Then to find some person with special knowledge of it to give an informal talk on it, and then open it for general remark and debate. It is hoped that the opening address will serve as a sort of a concentrator of thought and an excitor of discussion thereafter. It is the experience probably of many of you, as it has been mine, that the interest in meetings for the discussion of technical subjects is in a great many cases swamped by heavy, ponderous papers, the facts of which cannot be grasped, the theories comprehended, nor the intended deductions understood by those who listen to the reading of them. The Committee are agreed that papers of this character are not suited for meetings of this kind, and it will be their endeavor not to have any of the opening addresses or papers of such a character or length as to exceed the limit of elasticity of the attention of the audience.

The only rules which have thus far been adopted for the government of these meetings are:

1. The principal speaker of each evening to be requested not to occupy more time than 30 minutes.

2. Those who afterward take part in the discussion to be limited to five minutes, and no speaker to speak more than twice until all who wish to do so have spoken.

3. All members of the Society shall have the privilege of introducing or bringing friends to the meetings, who may take part in the discussion with the consent of the chairman.

I think I may also speak for the rest of the Committee in saying that it is not their intention to give these meetings a free-and-easy character. It is their purpose and hope to make these assemblages dignified meetings of the members of the leading engineering society of the country, to which we may all bring the most eminent and distinguished co-laborers in our own occupation from this and foreign countries, and when we do so, we want to be able to feel proud of our associates. It is hoped that to these meetings the mechanical engineers of this and other countries will bring the results of their ripest experience, their most profound knowledge, and share with each other those thoughts which they will want to leave behind them as part of the record of their lives and their labors.

Mr. C. W. Hunt, who had been invited by the Committee to preside at this meeting, was then introduced, and presided over the meeting.

The meeting was then opened, as was announced, by a paper by Mr. Hemenway on the Development of Stationary Steam Engines as illustrated by those at the Columbian Exhibition at Chicago, from which the following extracts are taken:

"To note progress, comparison must be made, and it is rather convenient, as well as common in this country to refer mechanical progress to the Centennial Exhibition. The interval between the Centennial and the Columbian Exposition—nearly 20 years—seems long enough for the purpose of fair comparison. Generally speaking, the steam-engine of 1893 will be found to be a better machine than that of 1876, made so by gradual advances, scarcely noticeable in some, and prominently so in other types.

"In the matter of compounding, compared with the Centennial, there was evidence of notable progress at Chicago. At the first-named exhibition there were no compound engines; at the last named, compound engines—two cylinder, triple and quadruple expansion—were the rule. Compounding is old, but at the date of the Centennial was not in repute for the more ordinary purposes for which steam-engines are employed. For such engines, at least, the economy of compounding was boldly disputed by some engineers, and more than questioned by others. Little doubt as to its superior economy exists to-day. Scarcely more than 10 years ago it was very easy to start a discussion between engineers as to the relative merits of simple and compound engines, as regards the economical use of steam. It is scarcely possible to do so now. That this is so is due to a better knowledge of the whole matter. The exhibits at Chicago, it seems to me, showed two things in relation to compounding, one of which was that progress has been made, and another that there is still room left for progress. There were some very fine examples, and some in which the effort to engraft the second cylinder upon the first was hardly felicitous. As one well-known engineer put it, the cylinders were not always neighbors, which may have covered other considerations than that of distance. But some undesirableness must be expected of anything in the transition state. A move in the right general direction, if not in the most direct line, represents progress compared with standing still.

"Comparison between the two largest engines—the Corliss at the Centennial and the Allis at Chicago—is unsatisfactory because of the difference in principle and in constructive de-

tail. One was a vertical and the other a horizontal, one simple, the other compound. Considered architecturally, to misuse a term for the sake of convenience, I should think there was nothing at Chicago that could compare very favorably with the Corliss at the Centennial. Probably in the best interest of progress there ought not to have been. In war there is perhaps nothing that will compare with the altogether useless charge of the Light Brigade. The Allis engine was of greater capacity, and, aside from this, it would, beyond doubt, furnish a H.P. for less expenditure of coal, and the chief end of a steam-engine is to furnish, all things considered, H.P. for little money. Both these engines were Corliss engines, as the term is employed at the present day, and the Centennial engine was certainly not behind in its mechanical performance. Nothing could behave more admirably as a machine.

"The most noticeable point of difference in the valve mechanism of these engines was the employment of a supplementary eccentric in the Allis engine for controlling the point of cut off. By the operation of this, the unlatching could occur at any point up to practically full-stroke. Objection, not very weighty, perhaps, but having some force, has frequently been made to the ordinary Corliss gear on simple engines because the steam-valves must be tripped, if at all, somewhat before the half-stroke of the piston. This objection, for obvious reasons, would have greater force in the instance of multi-cylinder compound engines. This second eccentric, as used, appears to be a desirable improvement. It is only proper, however, to say that the end aimed at by the use of this eccentric has for some time—and notably in England—been at least partially accomplished by the use of two eccentrics, one for the steam and one for the exhaust-valves. By this means it is possible to extend the point of unlatching until, practically, half-stroke, and this will prolong the expansion until about three-quarter-stroke, the piston at half stroke being at its fastest travel; this — three-quarter-stroke — is perhaps late enough for cut-off in any engine used for ordinary purposes.

"The time required for valve closure after unlatching in the Corliss type of engine was very well shown by an experiment made several years ago by some of the bright young students of Massachusetts Institute of Technology. This experiment was made with an 8-in. × 24-in. Harris-Corliss engine, by blocking the governor and loading the engine by means of a brake, then while the engine was running gradually, though comparatively quickly, releasing the brake friction, the pencil of the indicator being all the time in contact with the paper on the drum. By this means a series of diagrams were taken on a single card, the point of unlatching of the valve being, as explained, constant, while the speed of the engine increased as the load was decreased. The point of valve closure, as shown by these diagrams, was all the way from before half-stroke up to later than nine-tenths-stroke, the speed of the engine at the conclusion of the experiment being estimated at over 150 revolutions.

"It may be mentioned that gain in power, as shown by these diagrams, by prolonging expansion beyond three-quarter-stroke, was trifling, the increased forward pressure on the piston being nearly neutralized by an increase in the back pressure, although the steam line showed but little drop in pressure.

"It seems probable that there is some gain—and it is so stated by those familiar with the subject—in the use of separate eccentrics for steam and exhaust-valves through the possibility of a more advantageous arrangement of the exhaust-valves and their operating mechanism, as the steam-valves are not influenced by the change made in this respect. The use of separate eccentrics for steam and exhaust-valves, as referred to, was not, so far as I know, in evidence at Chicago, nor do I know when they were first employed. I am assuming that their use does not antedate the Centennial, in which I may be in error. They were, I am informed, so used by the E. P. Allis Company as early as 1886, but are not recommended by them except in the instance of the low-pressure cylinder of triple-expansion engines when it is desirable to carry expansion beyond half-stroke, and sometimes in the instance of two-cylinder compounds for the same reason. The chief reason why the two eccentrics are advised against by this Company is, I believe, the fact that the engine does not handle so conveniently when they are employed. I also believe, though I am not quite certain, that the Atlas Works, of Indianapolis, used two eccentrics something in the way indicated at an earlier date than that mentioned.

"Of the engines possessing to an extent greater or less some of the features of the Corliss, and designed to avoid what are claimed to be undesirable characteristics of this engine, not much can be said; the value of new arrangements of details should not be judged hastily, but time should be given in which to demonstrate their utility, or the contrary. Progress sometimes consists in going backward, which may or may not yet be illustrated in the instance of some of these engines at Chicago. There has, broadly speaking, been but little improvement in Corliss engines since the Centennial, and for some time previous to that. Some little modification of details has been made, undoubtedly in some instances of value, and a large amount of good material and workmanship, and a world of ingenuity have been wasted.

"One engine, the Bates-Corliss, was provided with a very neatly worked-out scheme for doing away with unlatching, at the same time preserving its equivalent. If unlatching is very objectionable, which I do not believe, this provides a way around it. As perhaps all of you know, there is in this plan a sort of doubling up, or back, in the steam-valve connection which is provided for by the operation of the governor; a sort of collapsing that may be likened to a toggle joint under pressure, forced beyond the center line and free to move further.

"This detail I suppose to be new, and it is, perhaps, yet to be demonstrated that something more objectionable than the unlatching of the Corliss motion is not developed by use. It appeared to work in every way satisfactorily.

"High-speed engineering cannot be said to have come into existence since the Centennial, but its growth has been mainly since that date. Previous to that the Buckeye Engine Company had built some quick-running engines for saw-mill work, I believe, and Mr. Charles T. Porter had built a few high-speed engines, and was engaged in missionary work, which he continued, and which has left his mark, if not as plainly written on rapid-revolution engines as that of Corliss on those of slow-revolution, quite as effectively perhaps, so far as results go. It is not necessary to mention the influence of the correct workmanship introduced by Mr. Porter, workmanship that made high speed practicable. All know of it, and thousands have profited by the example. In addition Mr. Porter originated a form of bed that has demonstrated a good many times that it is easier to modify and change something than it is to improve it. The outcome of his work—his example—was in indirect evidence at Chicago in the numerous examples of fine high-speed engines exhibited. Nothing like this exhibit would have been possible 15 years ago. This is particularly true of single-valve automatic high-speed engines with shaft governors, which have almost worked a revolution in some branches of steam-engine construction since the Centennial. There were, I believe, but two examples of stationary engines with shaft governors at the Centennial, the Buckeye and the small high-speed Straight Line by Professor Sweet. The latter has been so modified since then as hardly to be called the same engine. To these may be added the portable engine by Hoadley, making in all three engines with shaft governors. The portable engine named is not now built that I am aware of. These engines are referred to as showing the wonderful growth of this type of engine—those with shaft governors—as shown by contrast with the exhibits at Chicago.

"The discussion as to the relative merits of high and low-speed engines has been warm in previous years, the outcome of which is a pretty thoroughly settled conviction that each is best in its field, although the boundary lines are not very clearly defined. The high-speed engine has come to stay because it fills the proverbial "long-felt want," and the low-speed stays because its retirement would leave a void.

"Along with the requirement for better construction brought with the high-speed engine was that of improved methods of distributing oil. Getting a little oil, once in a while, where it would do some good, would not do, as the revolutions and reciprocations got way along up into the hundreds; getting the right quantity—or at least enough—at the right time, where it would do the most good, was demanded, and hence the ingenious arrangements to that end shown in connection with the engine exhibits at Chicago—all of modern growth.

"Something the same may be said of balancing. Correct practice in this respect was an essential of high speed, and a great deal of attention has been given to it and a good deal learned about it during the past 10 or 15 years. With the many examples of fine balancing shown at Chicago, it would be unfair to make special mention were it not for one instance of an engine—the *Ide*, I believe—which may be taken as an example of other practice; this engine was shown running very quietly, mounted on small wooden blocks—stilts.

"Great advances have also been made in controlling the speed of high-speed engines. So perfect is the best practice in this respect that almost any degree of refinement will be guaranteed. Progress in high-speed engineering was exemplified at Chicago, in part, by greatly improved design and workmanship, better means of lubrication, better balancing, and better control of speed.

"The display of steam-engines other than those made in the United States was so limited as to give but little idea of recent

European progress or practice; although we may in a general way be informed as to this, it would have been very satisfactory to have seen it better illustrated by exhibits.

"The Willans engine was an interesting example of comparatively recent date. Its special novelty is in its central valve for steam distribution, and the means for cushioning independently of the steam distribution in the cylinders. The central valve arrangement affords excellent means of getting rid of water in the cylinders, and the cushioning by means of the direct air cylinder results in smooth running without any effort at steam distribution to that end; something that I should think very likely to receive more attention in the future. This engine has what are usually believed to be the disadvantages of rather unusually short stroke, is single-acting, and has a throttling governor, and yet it is credited with remarkable economic performance. As to its performance under test, it may be remarked that with a properly adjusted load and constant steam pressure the objections to a throttling governor disappear. This engine is, I believe, used largely in England for electric lighting, the installation very commonly being such that of several engines only as many need be kept in operation as will be what is considered properly loaded, the governing being done by one engine. I am informed that they are manufactured strictly interchangeable in every detail; something that, so far as I know, cannot be said of any other engine. This does not necessarily make the engine better, but it must cheapen the cost of production.

"There was nothing, I should think, especially noticeable in the vertical German engine, except evidence of good design and workmanship. The use of the Rider cut-off valve never found especial favor in this country, which is not, however, said as in any way against it. Balancing the weight of the valves and connections by means of steam cylinders over them is not very new, at least; connecting the top of the balancing cylinders with, in the instance of the intermediate cylinder, the low-pressure steam-chest, and in the instance of the low-pressure cylinder, the condenser, while steam underneath the balancing pistons is taken from the respective steam-chests, may or may not be novel.

"The German portable and semi-portable engines were examples of elaborate construction beyond what we see in this country, but further than this, and the evidence of good general design, presented no very novel features.

"The French engine, by Schneider & Co., was mainly interesting as showing conclusive evidence of progress in the molder's art as applied to the making of castings for steam-engines.

"An evidence of the coming use of air cushioning was shown in the large Westinghouse engines by an air cylinder attachment to the high-pressure valve, which it would seem must assist the governor very materially.

"The most interesting example of progress in steam turbines appears to have been shown by the De Laval machine, in which a speed of as high as 30,000 revolutions is attained, the benefits of expansion being obtained by the use of a tapered nozzle, the smallest diameter being at the inlet. The commercial value of this machine may be doubted, but it is certainly, in its operation, a wonderful little engine.

"In direct-acting pumping engines notable progress since the Centennial was shown by the Worthington high-duty engine, with which you are all familiar. In direct-acting pumps of smaller size a good many have come into existence since that time, and as in steam-engines, compounding is fast gaining ground.

"Another noticeable feature is the growing popularity of independent condensing apparatus. Such apparatus has been in limited use for a long time, but it has been brought to its present state of perfection since the Centennial. Very fine adaptations were shown at Chicago, not less noticeable for their creditable operation than for compactness of arrangement and good general design.

"A great impulse was undoubtedly given to this branch of steam engineering by the advent of high speed, and recent progress, as illustrated at Chicago, has been very decided.

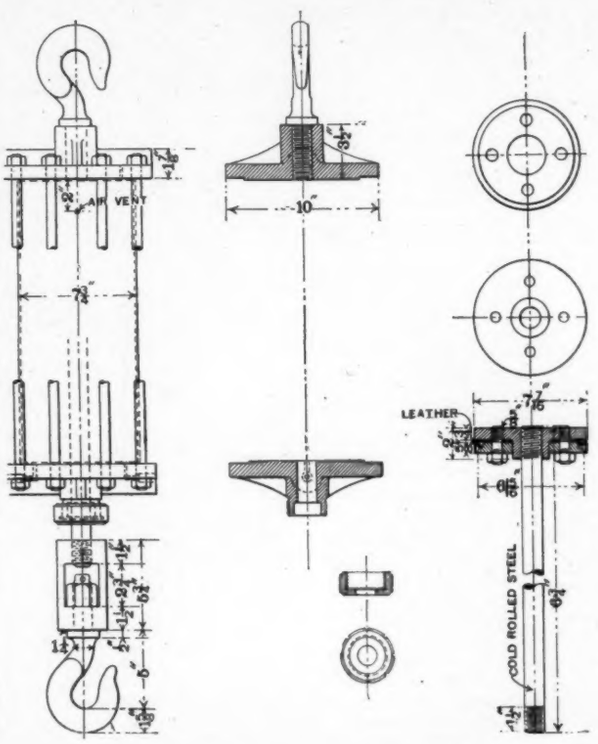
"An unfortunate feature of the engine exhibit was the numerous breakdowns and failures of some of the engines which were apparently in the experimental stage, something that was not to be expected at an exhibition of the character of this. It would seem to be a poor place to try experiments. Some failure is to be expected in the instance of a new departure in construction, and it is generally the case that some of the details must be changed or modified. But visitors generally conclude that this has already been attended to, as it ought to be, before public exhibition, and their criticism is, and justly, of what is and not of what might have been."

The paper was followed by an interesting discussion which lack of space prevents us from publishing.

PNEUMATIC HOIST IN THE SHOPS OF THE NEW YORK, NEW HAVEN & HARTFORD RAILROAD.

In our last issue we illustrated a pneumatic hoist which is in use in the shops of the Philadelphia & Reading Road, at Reading, Pa. These pneumatic hoists are becoming more and more common throughout the railroad shops of the country, and we know of one private shop in Ohio where the whole plant is thoroughly equipped with pneumatic arrangements for hoisting and conveying.

The New York, New Haven & Hartford shops, at New Haven, Conn., have quite a complete system of pneumatic arrangements for hoisting, and all of the large machine tools are provided with hoists. The plant consists of two Westinghouse pumps located in the engine-room, which supply the compressed air to a reservoir. The air is run under a pressure of about 75 to 80 lbs. to the square inch, and is led by pipes throughout the shops. Three sizes of hoists are used, two of which we illustrate in the accompanying engravings. These two are the largest and smallest that are used. The third one is intermediate between the two. It will be seen that in the larger hoist the cylinder is made of cast-iron heads bolted to flanges in the ordinary way. The hook beneath is held to a



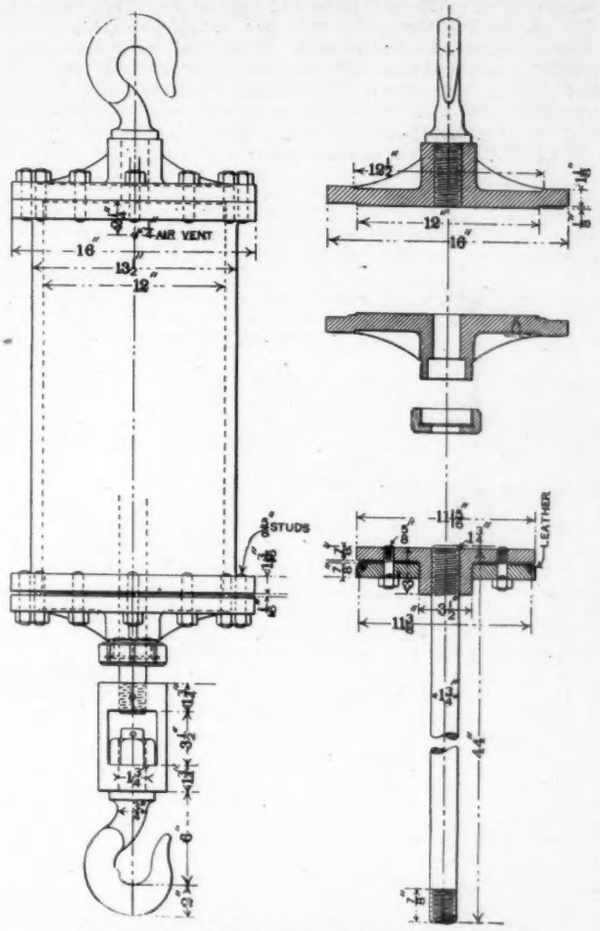
SMALL PNEUMATIC HOIST, N. Y., N. H. & H. R.R.

swivel chain, which is in turn screwed rigidly to the piston-rod. The general details of the piston and cylinder-heads are clearly shown on the engraving. The piston itself is a hub of cast iron with a leather cup packing bent down toward the piston-rod and held in position by a follower bolted up from the under side. This packing runs over a ring made of No. 3 spring wire, which allows an elasticity in the corner and serves to protect the leather from wear, as well as to give it a flexibility which is very desirable for this pneumatic work, where the pressure is apt to be suddenly applied, and unless there is a tendency to hold the latter out tightly there might be a detrimental leakage. The smaller of the two hoists, which is only 7¼ in. outside diameter, is made of a brass tube No. 8 stubs wire gauge. This tube is set into the cylinder-head at either end, which is in turn held together by eight ⅝ in. bolts, as shown on the engraving. These cylinders are hooked into a ring fastened rigidly into the overhead work of the shop, or else hung from trolleys which have a considerable movement and are supplied with air through a hose.

The largest size cylinder will readily pick up a pair of locomotive driving-wheels at the rate of, we should judge, 30 ft. a minute, which is rapid enough for any ordinary handling.

The length of the cylinders are made to suit the hoist which is required, but the larger size in the driving wheel shop are made 36 in. long, which gives a stroke of 33 in. In a future issue we trust to be able to publish a full and complete account of a pneumatic plant as applied to a large shop, showing all of the various apparatus that has been designed therefore.

The valves which are used on the New Haven Road are globe valves, admitting the air beneath the piston and exhausting into the atmosphere of the shops by the same means. The packing is tight enough, so that the weight can be held suspended safely without any danger of settling for an almost indefinite time. The uses of compressed air, as we have already said in describing the Norwalk air compressor in another column, is meeting with wider and wider applica-



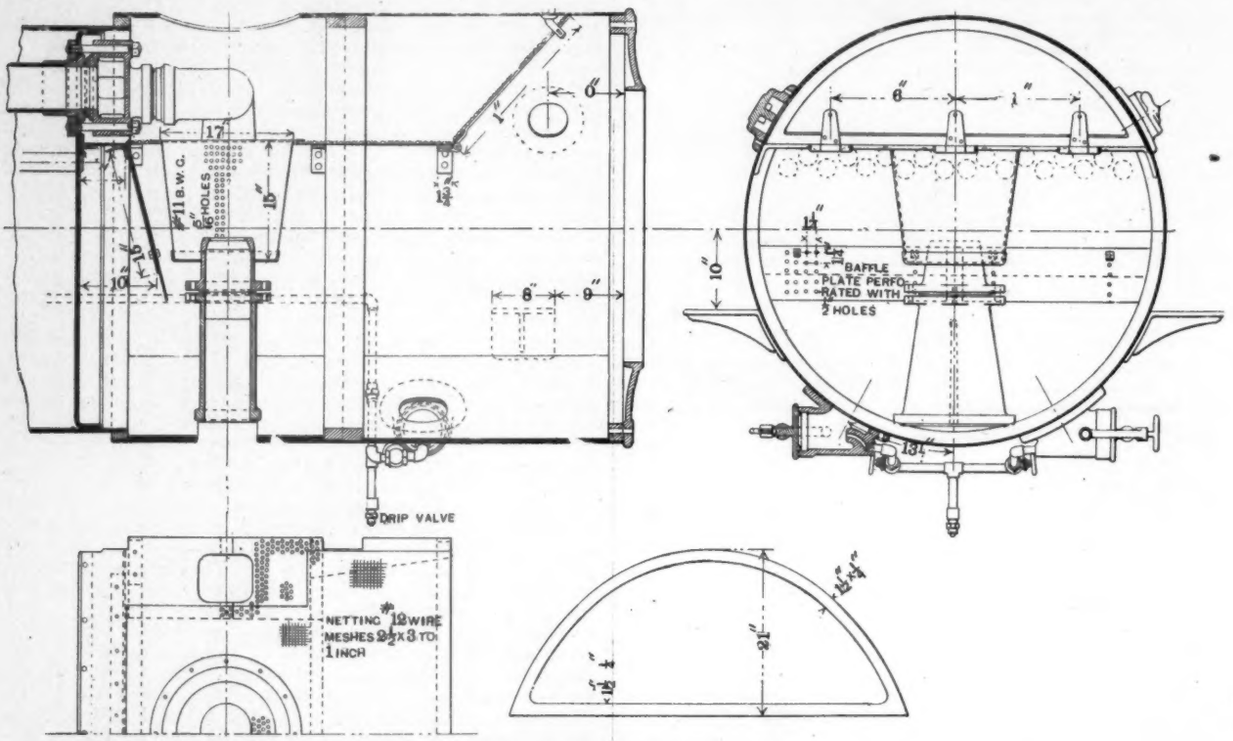
LARGE PNEUMATIC HOIST, N. Y., N. H. & H. R.R.

tion for shop uses and hoisting purposes, and is well worthy the investigation of those who are interested in the economical production of machine work.

THE FIRST-CLASS BATTLESHIP "ROYAL OAK."

THE *Royal Oak*, built by Messrs. Laird Brothers, of Birkenhead, is one of the largest battleships constructed for the British Navy, and was built under the Naval Defense Act. Her dimensions are: Length, 380 ft.; breadth, 75 ft.; mean draft, 27.6 ft.; displacement, 14,150 tons; freeboard forward, 19.6 ft.; aft, 18 ft.; indicated H.P. natural draft, 9,000; forced draft, 11,000; speed, natural, 16 knots: forced, 17¼ knots; coal carried at the designed load draft, 900 tons; coal endurance at 10 knots, 5,000 knots; total weight of armament, 1,910 tons; height of heavy guns above water-line, 23 ft.; length of the belt or side armor, 250 ft.; greatest thickness, 18 in.; protective deck, 3 in.; total weight of armor, backing, and protective deck, about 4,500 tons. As befits her enormous bulk and weight, the construction of the ship has been made exceptionally strong. The hull alone absorbs over 9,500 tons of the total displacement. She is built entirely of mild steel, the stem and stern-posts and shaft brackets being formed of steel castings. The hull from end to end is largely subdivided, for the purpose of minimizing to the fullest possible extent the danger arising from damage to the bottom plating from rocks or torpedoes, and that this form of construction is effectual was exemplified when H.M.S. *Howe* went ashore at Ferrol. The framework has been specially designed with reference to the great weight to be carried, and additional stiffness is secured by double longitudinal bulkheads, which form a passage for easy communication below the water line from end to end, and within these are placed the auxiliary magazines. A protective steel deck, 2½ in. in thickness, extends under water from the bow for about 76 ft., and from the stern for a distance of about 72 ft. From this deck, and resting upon an armor shelf, is built a belt of steel-faced armor, with a backing of teak. The lower edge of the belt extends 5 ft. 6 in. below the load draft-line, while the upper edge is carried 3 ft. above the line. The greatest thickness is 18 in., the belt itself extending over a length of 250 ft., out of a total length of 380 ft., and terminating in armored bulkheads. At the fore and after ends of the belt, and rising directly from the protective deck, are the barbettes, strongly framed in mild steel, protected by teak backing and armor 17 in. thick. Superimposed upon the thick belt is placed another belt of light armor, 4 in. thick at the sides and 3 in. on the screens, running across the ship, and behind this side armor coal bunkers are arranged, whereby additional protection is secured. On the level of upper edge of the armor belt there is also a 3 in. steel deck, worked so that horizontal deck protection extends from end to end. The guns are protected by 6 in. screens, and the gun crews by armored emplacements, and in order to procure a safe passage for the ammunition from the several magazines to the guns of the secondary armament, armored tubes have been specially fitted. It is also to be noted that, with a view of preventing water from finding its way below the protective deck, means are provided for closing the several openings by water tight covers, while in the case of those which must necessarily remain open, coffer dams have been fitted with the same object. She is lighted throughout with an installation of over 620 electric lights, and equipped with four search lights of 25,000-candle power, each of which will be worked by dynamos under protection. The ship in action will be fought from either of two conning towers, of which the forward one is armored to the extent of 14 in., and the after one to 3 in. The port and starboard engine and boiler-rooms are separated by middle-line longitudinal bulkheads extending the whole length, and there are also longitudinal bulkheads at the sides extending throughout the machinery space, forming coal bunkers and wing spaces. On the platform, *débris*, and lower decks is placed the auxiliary machinery for the working of the ship, including steering engines, electric engines, and hydraulic pumping engines, as well as a fully-equipped workshop and numerous store-rooms. The officers and crew are placed on the main and belt decks. The officers' accommodation consists of very completely fitted cabins situated aft, the superior officers being located on the main deck. The admiral's suite of rooms, which are especially handsomely fitted, are at the extreme aft end of the main deck, and communicate with a handsome stern walk. The upper deck extends from stem to stern without a break, and above it is a continuous bridge-deck extending the whole length between the barbettes, and on this deck are the conning towers surmounted by the navigating bridge and chart house. The boats, of which there are 21, including two torpedo-boats, are stowed amidships. A strong steel derrick is fitted to the mainmast for lifting them, and the foremast is also fitted with a derrick for working those of a lighter description. The masts, which are built of steel, are fitted with military and signaling tops, and there are two funnels on the same athwartship lines. The armament of the *Royal Oak* will comprise four 13.5-in. 67-ton guns, mounted *en barbette* in pairs, and firing a projectile weighing 1,250 lbs., with a powder charge of 630 lbs.; ten 6-in. 100-pdr. quick-firing guns, the four on the main deck being mounted in casemates protected by 6-in. armor, while the six on the upper deck are mounted on sponsons; sixteen 6-pdr., and nine 3-pdr. quick firers; eight small machine guns; and two 9-pdr. field guns. The auxiliary armament is distributed all over the ship, and extends from bow to stern, the top, sides, and bridges having a considerable number disposed upon them. The main armament is worked by hydraulic machinery, supplied by Sir W. Armstrong, Mitchell & Co. The other guns are all worked by hand, the 6-in. by one man, the others being employed for feeding purposes. The ship is also fitted with seven torpedo tubes, of which two are submerged. The number of torpedoes carried is 18. The main propelling machinery consists of two sets of engines of the triple-expansion inverted type. Each set is placed in a separate engine-room. The cylinders are 40 in., 59 in., and 88 in. in diameter respectively, with a stroke of 51 in.; they are entirely independent castings, and are bolted together by

brackets. The receivers consist of copper pipes attached to gun-metal branches, and expansion joint stuffing-boxes. The whole of the cylinders are steam jacketed, the working barrels of the high-pressure being of forged steel, and those of the low and intermediate-pressure cylinders of cast iron; the slide-valves for the high and intermediate pressure being of the piston type, whereas the low-pressure cylinders have flat double-ported valves. A special type of relief ring is fitted at the back of these flat valves. Balance cylinders are fitted to the high-pressure and intermediate valves, and assistant cylinders to the low, to reduce the strain on the valve-gear as far as possible. The valve-gear is of the double-eccentric link-motion type, and is moved by means of a double-cylinder starting engine. The columns are of wrought steel. The main condensers, which are of brass, have a collective cooling surface of 14,500 sq. ft. The steam is condensed outside the tubes, the circulating water passing through them. The water is supplied by four 18-in. Allen's centrifugal pumps, each driven by an independent engine. Suctions are also led to the bilges from these pumps, which give a total bilge pump power of 4,400 per hour. The crank-shaft for each set of engines is in three separate pieces, the cranks being set at 120° to one another. The crank, thrust, and propeller-shafts are all hollow, an 8-in. hole being bored through their entire length, and they are each forged from a solid steel ingot. The thrust-blocks and collars are of cast steel. The latter are lined with white metal, and are of the ordinary type. The screw propellers are four-bladed, the blades and bosses being of gun-metal. Steam is supplied by eight single-ended cylindrical return-tube boilers, working at 155 lbs. pressure per square inch, and being 15 ft. 4 in. in diameter and 9 ft. 4 in. long, each boiler having four corrugated furnaces 3 ft. 4 in. in diameter. The total grate surface is 710 sq. ft., and the total heating surface 20,174 sq. ft. For the purpose of shutting off each combustion chamber from the others, and also for regulating the draft in same, separate dampers are fitted in the passage from each through the smoke-boxes, and gear arranged to work the same conveniently from the stokehold floor. Following out the principle of subdivision, each two boilers are in a separate water-tight compartment, with independent coal supply, separate access to and from main deck, etc. The exhaust steam from the whole of the auxiliary machinery in the ship is led into an auxiliary exhaust pipe, which is connected both with the atmosphere by means of the auxiliary waste steam-pipes carried up outside the funnels, and with the two auxiliary condensers, one in either engine-room. Each of the latter condensers has its own air and circulating pump entirely independent of those for the main condensers, and worked by independent engines. The combined cooling surface of these two auxiliary condensers is 1,800 sq. ft. In the main engine-rooms there are also two double-cylinder turning engines, two evaporators with independent feed pumps, two distillers with circulating and distributing pumps, four No. 2 Admiralty type main feed pumps, of ample size to supply the whole of the boilers in full power, and four double-cylinder double-acting bilge and fire pumps of No. 1 Admiralty type. A pump for pumping out the drain tank, and two ventilatings fans 6 ft. in diameter, each driven by a separate steam engine. In the boiler compartment there are eight fans 5 ft. 6 in. in diameter, each with its separate engine, for supplying the forced draft for the boilers, and also four double-cylinder double-acting auxiliary feed pumps of No. 2 Admiralty type. The weight of the anchors and chain cables is 130 tons, and if the cables were laid out in a single line they would extend about one mile. The total weight of metal work treated in the construction is upward of 9,000 tons, and the wages expenditure in Birkenhead represents considerably over £220,000, which is, of course, exclusive of labor in manufacture of armor plates, forgings, and a variety of fittings from sub-contractors.—*The Engineer.*



CROMWELL'S SMOKE-BOX.

CROMWELL'S SMOKE-BOX.

THE engravings illustrate a form of smoke-box designed and patented by Mr. A. I. Cromwell, Superintendent of Motive Power of the Baltimore & Ohio Railroad, and which is in use on that line.

Immediately over the exhaust-pipe a "basket," as it is called, made of perforated metal plates, is placed. This is of the form of a frustrum of a cone, as shown. The open top of this is attached to horizontal wire netting, as shown, and encloses the top of the exhaust-pipe or exhaust-nozzle. The effect of the blast is to draw the products of combustion through the perforations in the basket. The smoke and flames are thus drawn through the tubes. In front of these openings, which lead into the smoke-box, an inclined deflecting plate is placed, which causes the currents to be deflected downward and toward the front of the smoke-box. They then turn upward and part of them pass through the openings in the basket and part pass through the netting. They thus momentarily, as it were, come to a state of rest, when the cinders fall and remain in the bottom of the forward end of the smoke-box, from which they may be removed by the spark ejector, shown very clearly in the front-end view.

This arrangement has been applied to a number of engines on the road referred to, and is working very satisfactorily.

THE RIVETING PRESSURES REQUIRED FOR BRIDGE AND BOILER WORK.

AT a general discussion of this subject before the Engineers' Club of Philadelphia, Mr. Wilfred Lewis referred to a number of letters received expressing interest in the subject, and read a letter from Mr. David Townsend stating that he was prepared for the manufacture of rivets to be driven cold, a number of which were exhibited.

In regard to the pressure required for driving such rivets, Mr. Lewis recalled some experiments made by William Sellers & Co., Incorporated, between the compression platforms of their testing-machine. A number of ¾-in. rivets were subjected to pressures between 10,000 and 60,000 lbs. At 10,000 lbs. the rivet swelled and filled the hole without forming a head. At 20,000 lbs. the head was formed and the plates were slightly pinched. At 30,000 lbs. the rivet was well set. At 40,000 lbs. the metal in the plate surrounding the rivet began to stretch, and the stretching became more and more apparent as the pressure was increased to 50,000 and 60,000 lbs. From these experiments the conclusion might be drawn that the pressure required for cold riveting was about 300,000 lbs. per square inch of rivet section. In regard to the pressure for hot riveting, he said that until quite recently, within the last decade, there was never any call for a pressure exceeding 60,000 lbs., but that now pressures as high as 150,000 lbs. were not uncommon, and even 300,000 lbs. had been contemplated as desirable.

A letter from Mr. Henry G. Morse, President of the Edge Moor Bridge Works, was also read apropos of the discussion at the previous meeting on the strength of bolts as developed by long or short nuts.

Mr. F. H. Lewis: I have never seen a riveter of any kind that can always be relied upon to drive the rivets tight. Even those having pressures of 75 tons sometimes drive rivets that are loose, and this is probably due to the buckling of the plates.

Mr. Henry G. Morris: I have here an old sample which is intended to show that even the old toggle-joint riveter, if properly worked, will drive rivets that fill the holes even when they are badly matched.

Mr. Henry J. Hartley: This is a question which is occupying a great deal of attention at present among bridge and boiler men, and I know that some series of tests to get at the facts are now being carried on. The necessary pressure must, of course, be enough to upset the bolt and form a head upon it; but this will vary with the fitting of the holes, the temperature, and several other conditions. Books give little data on the subject, but I think the matter is of great importance, and would like to see it continued at another meeting, with the hope that more positive facts can be given. I, for one, will try to have something a little more definite. My personal opinion now is that machine-driven riveters do better work, and that the fault lies in the way that they are used, the riveter being generally run at one pressure, no matter what the diameter of the bolt and the thickness of the plates.

Mr. James Christie: I remember many years ago in the West they used to drive boiler-rivets cold, but afterward abandoned it on account of the deterioration in quality of the rivet iron.

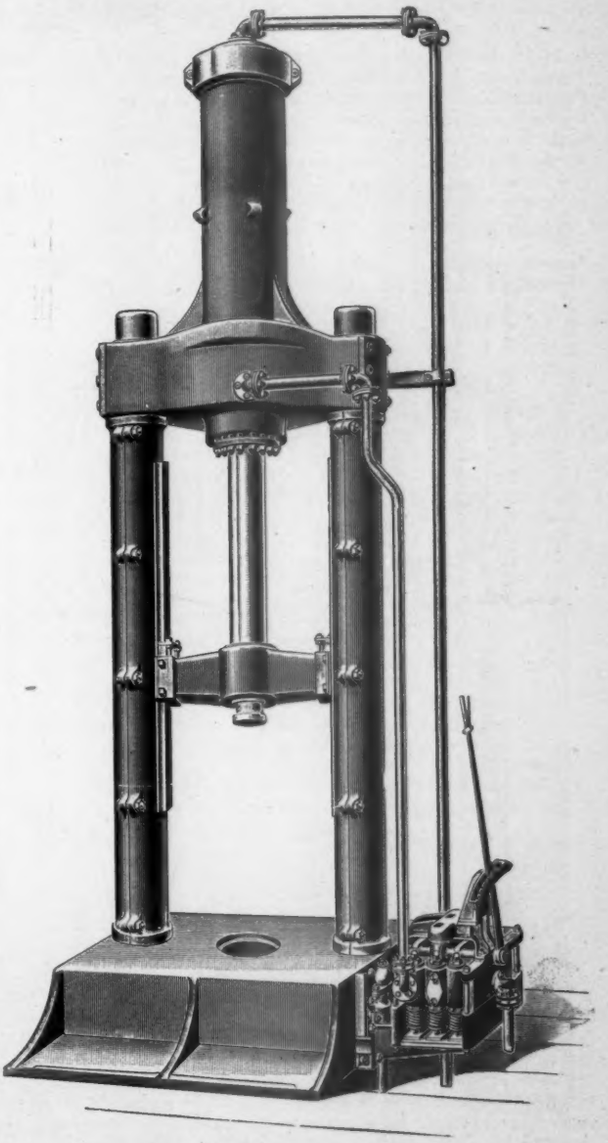
Since critical systems of inspection and testing material have become common, the importance of having rivets solidly driven has been more thoroughly appreciated than formerly. Hand work is avoided where possible, and higher pressures are used than before. Machines are preferred that will deliver the maximum pressure to the rivet with certainty. The direct hydraulic ram has the advantage of compactness, and when its fluid is stored in an accumulator there is a sudden impact or elevation of static pressure on the rivet at the termination of each stroke—a circumstance highly favorable to the riveting operation.

It has been found in girder work, that for red-hot rivets of iron or soft steel, with length of grip not exceeding three diameters, a pressure of 50 tons per square inch of rivet section has been sufficient to completely fill the hole. Longer rivets require higher pressure, and in extreme cases this pressure must be doubled to secure solidity. The shape of the head can be modified to a form favorable for the flow of metal into the body. The results of some experiments are submitted on the board, illustrating the advantage of high pressure on the riveted joint.

At a subsequent meeting Mr. Henrik V. Loss exhibited a number of indicator cards taken by him from a bridge riveter at the Pencoyd Bridge Works a couple of years ago, by using a common steam indicator in connection with a pressure producing cylinder. These showed great variation in pressures existing with rivets of one dimension, amounting to about 50 per cent. for ¾-in. rivets, and 25 per cent. for larger ones. Although it is almost useless to try to formulate definite rules for the power necessary to do the work, it will be seen that if the average be introduced in comparing the two sizes, this average pressure amounts to about 1,800 lbs. per square inch on a 10-in. cylinder, which, when subtracting the pullback, gives 65 tons for either ¾ or ⅞-in. rivets. Does this mean that a large rivet takes no more power than a smaller one?

It is a fact that in many cases of upsetting, a small rivet requires greater power than a large one, probably due to the rapid cooling effect of the surrounding cold dies upon the heated bar.

A greater pressure, however, is necessary for boiler work, and ¾ or ⅞-in. rivets with grips like those used in bridge work



16-INCH PROJECTILE PRESS.

would require at least 75 to 80 tons, although for the smaller grips that usually prevail a pressure of 65 tons for the above dimensions would be sufficient. Upsetting a short rivet is a fair test of the strength of metal, for which definite rules can doubtless be laid down for the power required with reference to the diameter, but with long rivets this becomes almost impossible, as it can readily be supposed that for each length there is a corresponding diameter, which will give the smallest resistance per square inch of metal, a fact which was corroborated by the great irregularities in power lines of the cards shown that were taken from this class of work.

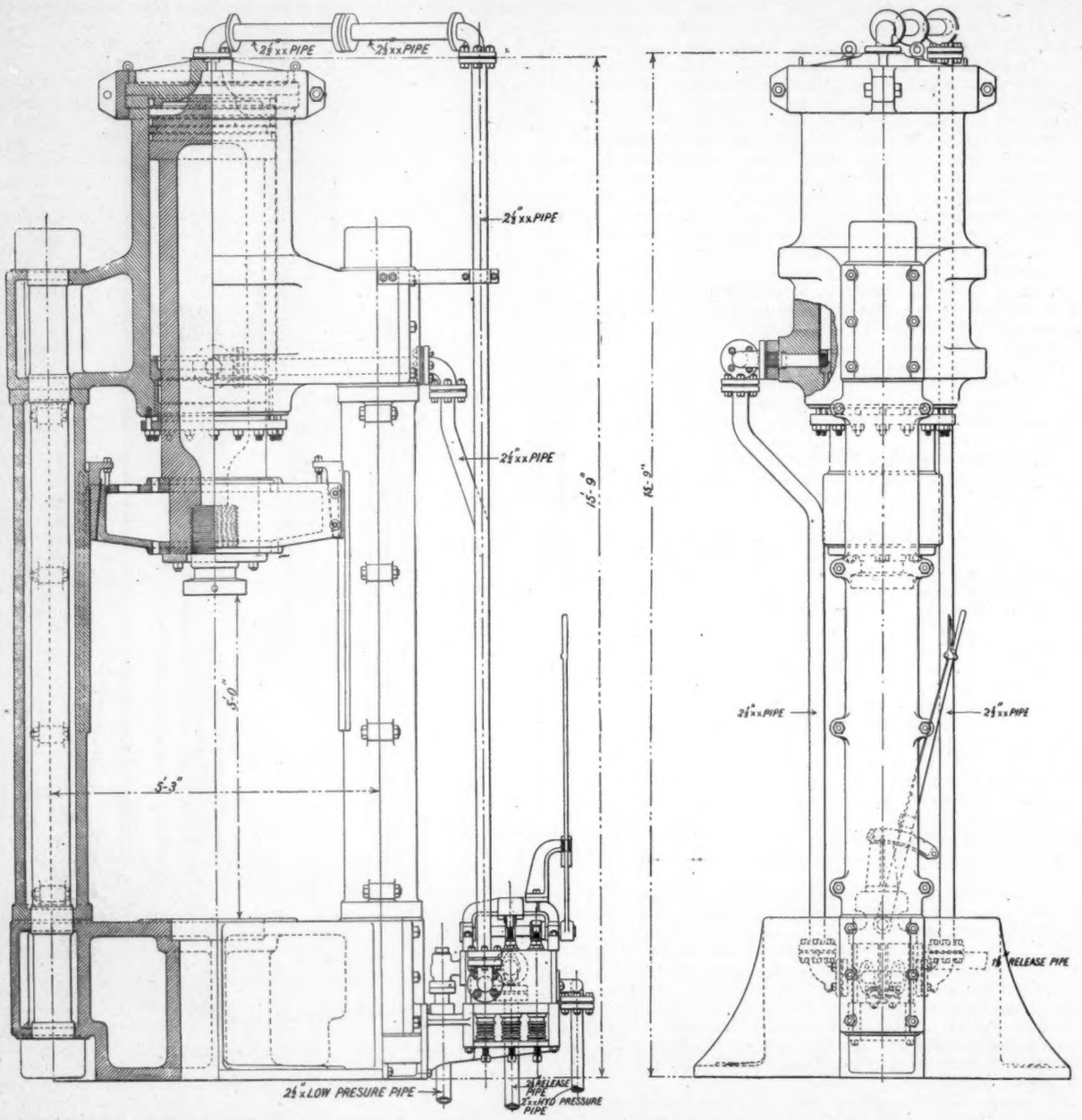
With regard to the energy consumed, a ¾-in. rivet needs about 7,200 foot-pounds, while a ⅞-in. rivet requires about 9,500 foot-pounds to form a head and fill the hole, if the work is about in the proportion of the squares of the diameters.

Whether this relation holds good for other dimensions will have to be determined by further experiment. It has been observed also that the energy in foot-pounds necessary to upset a rivet and the displacement of metal in the rivet due to the upsetting are in the same ratio.

Mr. James Christie: I have observed that the pressure required to upset small rivets is very much larger per unit of area and sometimes absolutely greater than for large rivets. It is very important to consider in this connection the character of the holes and the resulting resistance to flow of the metal. With 1¼-in. rivets, we have always found a pressure of 150 tons amply sufficient to make a tight joint and have the 1½ in., and riveted with pressures varying from 25 to 100 tons. It was found that the best pressures to use for different sizes of rivets were as follows: For ⅝-in., 25 tons; for ¾-in., 33 tons; for ⅞-in., 50 tons; for 1-in., 66 tons; for 1⅛-in., 75 tons, and for 1¼-in., 100 tons.

We have found that the rivet to make a close joint should be hotter under the head than at the end, and if it is equally heated we cool the end by dipping it in water immediately before inserting it in the plates.

Mr. Jeffries (*visitor*): A series of exhaustive experiments were made at the Naval Dock Yards in England, which gave results almost identical with those described by Mr. Vauclain.



SIDE AND FRONT ELEVATION OF 24-INCH GEAR PRESS, BUILT BY WATSON & STILLMAN.

rivets fill the holes. The latter is the main consideration, and to accomplish it it would seem that the higher the pressure the better, up to a point where the plates would be put under dangerous tension by the expansion of the rivet body.

Mr. S. M. Vauclain: A very important point to be considered is the condition of the rivet itself before being driven. It should be at exactly the right heat, and this is difficult to determine except by repeated trials. With iron rivets and poorly made holes we have found in boiler-work that it does not take very heavy pressures to fill the holes, provided the rivets have been properly heated. In one test that I made at the Baldwin Locomotive Works, I had six plates of ⅝-in. iron drilled with holes of diameters varying by ⅛ in. from ⅝ to Several years ago it was found that with thicknesses of ⅝ and ¾-in., plate closing was entirely unnecessary, but with 1-in. plates and thicker, it seems at least to be very desirable. The difference of opinion on this subject is probably due to the lack of uniformity in the method of operating the closing and riveting pressures successively. The closing pressure should be maintained for just the right length of time and then the pressure transferred to the rivet. A press to do this accurately has been designed, I believe, but is not yet used extensively in practice.

Mr. Wilfred Lewis: William Sellers & Co., Incorporated, have built a machine in which the pressure can be accurately managed by the operator, so as to be applied first to

closing and then transferred to the rivet. I have a letter from Mr. John T. Boyd, in which he speaks of hydraulic riveting as being preferable when it can be used, and recommends a plate closer when there is not absolute certainty of the riveting machine making tight work without it. He also favors an accumulator in which the weights can be dropped to vary the pressure applied to rivets on plates of varying thickness as opposed to one which furnishes uniform pressure for all kinds of work. He quoted excellent results obtained in riveting with pressures not exceeding 20,000 lbs. per square inch of area covered by the formed head of the rivet, but believed that the make of rivets and the thickness of plates should be taken into account to secure the most satisfactory results. A great degree of uniformity in heating rivets can be obtained with an oil or gas furnace.

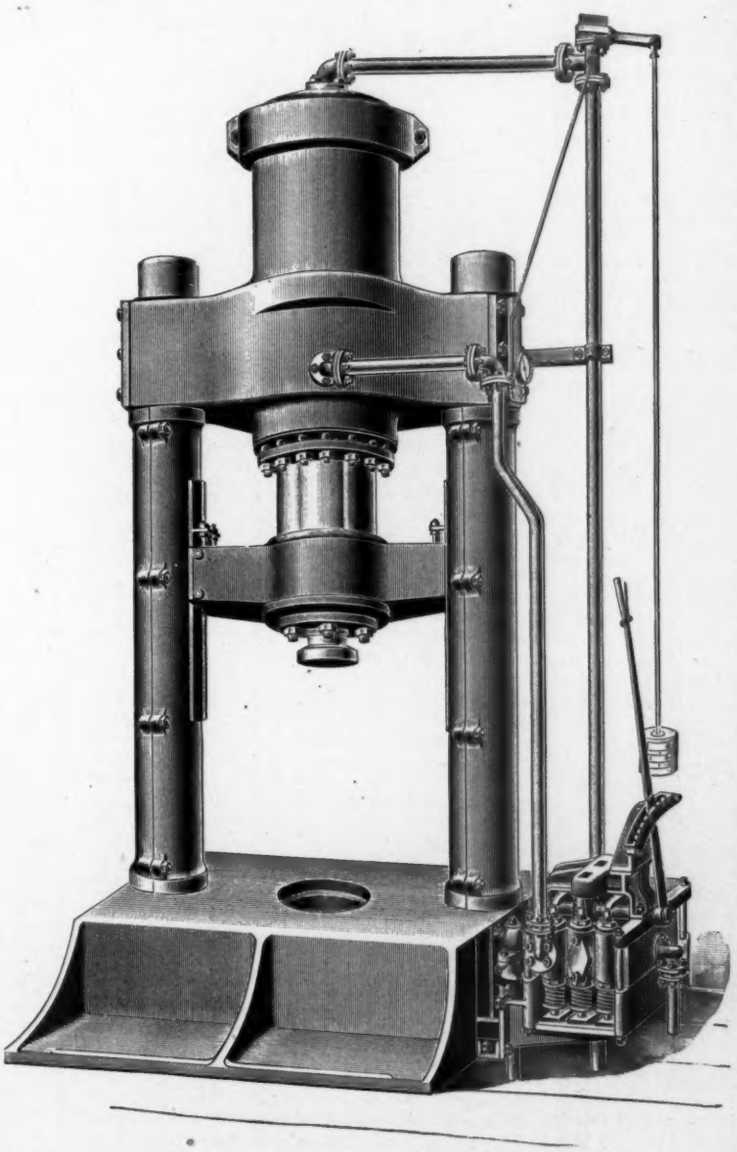
Mr. James Christie: I may say that we have found in bridge work, in driving rivets of $\frac{7}{8}$ to 1 in. diameter through thicknesses of 5 or 6 in., that it was best to use a plain bar and form a head on both ends at the same time.

Mr. John Birkinbine: From what has been said it would seem that the most important feature—namely, the quality of the iron in the rivets, is often neglected in its consideration; but in locomotive boiler and in bridge work, where many lives are dependent upon it, it would seem that nothing but the best quality obtainable should be considered as fit for use.

Preserving Tools from Rust.—A good plan for preserving tools from rusting is the simple preparation employed by Professor Olmstead, of Yale College, for the preservation of scientific apparatus, and which he long ago published for the general good, declining to have it patented. It is made by the slow melting together of six or eight parts of lard to one of resin, stirring till cool. This remains semi-fluid, ready for use, the resin preventing rancidity and supplying an air-tight film. Rubbed on a bright surface ever so thinly it protects and preserves the polish effectually, and it can be wiped off nearly clean, if ever desired, as from a knife blade, or it may be thinned with coal oil or benzine.—*Royal Engineers' Journal.*

PROJECTILE AND GEAR PRESSES.

THE United States Projectile Company, a portion of whose machinery is illustrated in another column, is engaged not only in the manufacture of rapid-fire, solid drawn projectiles of 4, 5, and 6 in. diameter for the United States Government, but also of gears and pinions for usage in certain places where the service is very severe. We illustrate herewith two presses which were made for them by Messrs. Watson & Stillmann, the hydraulic machinery manufacturers of New York.



24-INCH GEAR PRESS, BUILT BY WATSON & STILLMAN.

The larger of the two presses shown has a cylinder 24 in. in diameter and 48 in. double-acting stroke, and the smaller have 10 in. and 16 in. rams of 48, 60, and 72 in. stroke. The larger is intended for gear work, and is used in forcing the blank of the gear through the dies from which it emerges compressed and finished.

The smaller presses, although less powerful, are doing the more interesting work. The heated projectile blank is placed beneath the ram and forced through dies which it leaves true in shape, straight, and ready for the trimming machine, which is illustrated in another column. The general construction of these presses is very clearly shown in the accompanying engravings. The upright cylinder is supported by two columns, one on either side, giving a free opening beneath for the handling of the material. The head of the ram has a cross-head with adjustable bearings guiding upon the upright. The end of the ram has a special shaped head for clamping the drawing tools to it. The accessibility of the packings is a prominent feature of the press design. The valve which is located upon the right of the press is in one of them beneath the level of the floor and is of peculiar construction, the valves being so balanced that they are readily operated and cause no trouble whatever.

The larger of the two presses is provided with a safety-valve on the top, so as to prevent excessive pressure. These machines are very powerful and occupy very much less floor space than those which were previously in use by the Projectile Company. The pressure of 2,500 lbs. to the square inch, which is used, gives upon the ram of 16 in. in diameter a pressure of 502,655 lbs., and on the 24-in. press the enormous pressure of 1,130,975 lbs.

In addition to the large accumulator carrying a heavy pressure there is one carrying a lower pressure of, say, from 100 to 125 lbs. to the square inch, and this is so arranged in connection with the valves that the plunger can be brought down to the work or to a point at which it begins to force the shell or the gear through the die. Thus this movement is accomplished without exhausting water which has been pumped into the accumulator under a pressure of 2,500 lbs. to the square inch, saving a considerable amount in foot-pounds of power. When the plant is operated in full force it is considered that this duplication and use of low-pressure system will effect a saving of more than 2 tons of coal per day.

The makers are not ready as yet to publish the details of this valve, but we hope in a future issue to be able to show the complete construction. It will be seen from the engravings that there are three valves held down by springs and operated by the lever moving through a quadrant on the side of the machine.

LOCOMOTIVE RETURNS FOR THE MONTH OF OCTOBER, 1893.

Name of Road.	Number of Serviceable Locomotives on Road.	Number of Locomotives Actually in Service.	Locomotive Mileage. Passenger Trains.	Freight Trains.	Service and Switching.	Total.	Average per Engine.	Av. Train. Passenger Cars.	Freight Cars.	Coal Burned per Mile. Passenger Train Mile.	Freight Train Mile.	Service and Switching Mile.	Train Mile, all Service.	Passenger Car Mile.	Freight Car Mile.	Cost per Locomotive Mile. Repairs.	Fuel.	Oil, Tallow and Waste.	Other Accounts.	Engineers and Firemen.	Wiping, etc.	Total.	Cost per Car Mile. Passenger.	Freight.	Cost of Coal per Ton.
										Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	$
Atchison, Topeka & Santa Fé	822	744	.....	.... ..	. . ....	2,273,337	3,056	....	....	....	....	....	82.67	....	...	3.93	7.42	0.20	0.14	6.77	1.23	19.60	....	...	1.71
Canadian Pacific	615	....	534,665	878,362	503,634	1,916,661	3,116	....	....	...	....	....	71.65	....	...	3.39	11.53	0.32	....	5.76	1.25	22.25	....	....	3 18
Chic., Burlington & Quincy	541	....	.....	.....	.....	1,767,058	3,266	....	...	....	....	....	86.84	....	..	3.53	5.79	0.20	0.15	6.47	0.05	16.19	....	....	1.34
Chic., Milwaukee & St. Paul	856	....	.....	.....	.....	2,875,011	3,358	6.75	19.33	....	....	....	68.38	....	....	3.52	7.81	0.27	...	6.66	...	18.26	....	....	2.38
Chic., Rock Island & Pacific	564	....	601,128	1,152,073	367,880	2,121,081	3,761	....	....	66.66	81.07	41.52	70.67	....	....	2.74	6.76	0.24	2.74	6.11	0.33	18.92	.. .	...	2.04
Chicago & Northwestern	1010	....	907,808	1,578,767	690,665	3,177,240	3,146	....	...	....	...	....	88.92	.. .	....	2.98	7.94	0.30	....	6.32	0.72	18.26	...	....	1.76
Cincinnati Southern	....	....	.....	.....	.....	.....	....	....	....	...	....	....	....	....	...	...	....	....	...	....	....	....	....	....	....
Cumberland & Penn.*	23	23	6,509	35,119	.....	41,628	1,809	....	....	....	....	....	81.11	....	...	7.82	4.40	0.38	....	...	1.78	14.38	....	....	....
Delaware, Lackawanna & W. Main L.	211	194	72,565	198,825	434,399	705,789	3,638	....	....	.. .	...	....	89.12	....	....	2.57	6.81	0.43	....	5.96	....	15·77	....	...	1.60
Morris & Essex Division	162	....	182,053	152,079	102,352	436,484	3,064	....	....	...	....	....	60.79	....	....	3.64	9.52	0.43	....	6.47	....	20.06	....	....	3.10
Hannibal & St. Joseph	72	72	.. ..	.. ...	.....	284,512	4,007	5.90	16.54	....	....	....	84.85	12.51	6.69	2.28	7.16	0.14	0.40	6.59	0.01	16.55	....	....	1.76
Kansas City, F. S. & Memphis	152	....	94,505	229,945	91,981	416,431	2,776	....	....	....	....	....	64.83	....	....	3.34	5.44	0.33	0.35	7.31	...	16.77	....	....	1.68
Kan. City, Mem. & Birm	42	40	33,977	57,802	12,092	103,871	2,597	....	....	..	....	....	62.77	....	....	2.69	3.50	0.22	0.32	6.96	....	13.69	....	....	1.06
Kan. City, St. Jo. & Council Bluffs	38	38	.....	.....	.....	134,016	3,527	5.53	22.37	....	....	. ..	71.04	13.82	4.71	3.82	6.45	0.15	0.49	6.30	0.04	17.25	....	....	1.88
Lake Shore & Mich. Southern	593	....	543,724	816,026	436,455	1,796,205	3,382	....	....	72.67	88.88	38.72	71.71	....	....	1.93	5.62	0.12	0.06	6.87	0.15	14.75	....	...	1.57
Louisville & Nashville	....	....	.....	.... ..	.....	... .	...	.. .	...	.....	...	....	...	....	....	..	....	....	....	....	....	....	....	....	....
Manhattan Elevated	....	293	760,238	.....	67,332	827,570	....	....	....	...	....	....	40.48	....	....	2.20	8.00	0.20	....	9.20	....	19.60	....	...	3.94
Mexican Central	148	115	... .	.....	.....	376,868	3,277	...	...	....	....	....	67.82	....	....	5.38	13.55	0.35	0.20	4.72	0.74	24.94	....	....	4.40
Minn., St. Paul & Sault Ste. Marie	....	....	86,129	153,60[2]	64,72[5]	304,456	....	4.99	21.01	...	....	....	51.19	....	....	3.30	12.66	0.22	....	6.44	....	22.62	....	....	3.70
Missouri Pacific	336	....	.....	.....	..... .	1,026,406	3,579	4.40	16.69	....	....	...	84.17	....	....	3.07	6.02	0.33	1.12	6.27	1.30	18.11	3.59	1.30	1.39
Mobile & Ohio	107	80	76,661	139,773	56,381	272,810	3,410	. ..	....	....	....	....	62.56	....	....	2 04	4.58	0.22	0.64	5.75	0.89	14.07	....	...	1.43
N. O. and Northeastern	....	....	.....	..... .	.....	.. ..	....	....	....	....	....	....	..	....	...	...	...	...	....	....	....	....	....	....	...
N. Y., Lake Erie & Western	639	424	488,365	855,402	259,486	1,603,253	3,781	5.40	24.30	92.10	139.80	79.25	103.71	17.20	5.80	4.01	7.81	0.38	2.54	7.46	1.14	23.34	....	....	1.38
N. Y., Pennsylvania & Ohio	267	182	215,805	368,449	129,510	713.755	....	6.40	18.60	75.90	132.30	91.55	99.90	...	....	3.92	5.87	0.31	2.05	7.13	0.95	20.23	....	. ..	1.12
Norfolk & Western, Gen. East. Div.†	....	....	93,21[3]	300,595	42,185	445.993	2,655	5.70	20.90	56.20	127.20	....	91.70	9.80	6.10	3.91	4.02	0.29	....	...	....	8.22	....	...	3.00
General Western Division†	....	....	110,807	309,335	46,339	466,481	2,667	5.70	17.30	....	....	...	125.00	13.66	8.20	4.92	4.61	0.28	....	....	....	9.81	0.77	1.33	....
Ohio and Mississippi	....	....	.....	.....	.....	.. ....	...	....	....	...	....	....	....	..	....	...	....	....	....	...	....	...	....	....	....
Old Colony Div. N. Y., N. H. & H	....	...	530,201	190,675	245,617	967,573	....	3.80	16.70	....	....	7	78.30	16.80	4.70	2.60	9.21	0.63	....	6.91	0.90	20.25	....	...	....
Philadelphia & Reading*	....	....	466,207	328,725	1,046,464	1,841,396	....	....	....	....	....	....	73.12	....	. ..	4.95	4.70	0.37	..	5.83	0.40	16.25	....	....	....
Southern Pacific, Pacific System	741	669	644,655	1,042.908	281,149	1,968,712	2,943	5.53	14.04	....	....	....	70.42	....	....	3.91	17.18	0.22	1.95	7.38	1.02	31.66	...	...	4.68
Union Pacific	1024	863	562,432	1,359,903	301,430	2,223,765	3,712	....	....	...	....	. ..	86.43	....	....	6.56	8.30	0.40	....	7.90	1.01	24.17	...	....	1.92
Wabash	425	353	502,479	611,439	236,380	1,340,298	3,797	5.73	17.78	78.15	107.06	53.85	88.18	13.68	6.02	3.46	5.01	0.32	...	6.13	0.86	15.78	2.10	1.04	1.16
Wisconsin Central	149	114	124,498	192,190	599,060	376.648	3,305	....	....	....	....	...	81.49	....	....	3.02	9.61	0.20	...	6.61	...	19.44	....	....	2.34

NOTE.—In giving average mileage, coal burned per mile and cost per mile for freight cars, all calculations are made on the basis of *loaded* cars. Empty cars which are reckoned as one loaded car are not given upon all of the official reports, from which the above table is compiled. The Union and the Southern Pacific rate two empties as one loaded; the Kansas City, St. Joseph & Council Bluffs and Hannibal & St. Joseph Railroads rate three empties as two loaded; and the Missouri Pacific and the Wabash Railroads rate five empties as three loaded, so the average may be taken as practically two empties to one loaded.

* Switching engines allowed 6 miles per hour; wood, construction and gravel trains, 10 miles per hour.

† Wages of engineers and firemen not included in cost.

ACCIDENTS TO LOCOMOTIVE ENGINEERS AND FIREMEN.

THE object of publishing this monthly list of accidents to locomotive engineers and firemen is to make known the terrible sacrifice of life and limb that is constantly going on among this class of people, with the hope that such publication will in time indicate some of the causes of accidents of this kind, and help to lessen the awful amount of suffering due directly and indirectly to them. If any one will aid us with information which will help to make our list more complete or correct, or who will indicate the causes or the cures for any kind of accidents which occur, they will not only be doing us a favor, but will be aiding in accomplishing the object of publishing this report, which is to lessen the risk and danger to which the men to whom we all intrust our lives are exposed.

The only, or the chief source of information we have, from which our report is made up, is the newspapers. From these the following list of accidents, which occurred in December, has been made up. Of course we cannot report those of which we have no knowledge, and doubtless there are many such.

ACCIDENTS IN DECEMBER.

Columbia, Pa., December 2.—Mart M. Hinkle, an engineer on the Pennsylvania Railroad, received a painful injury today. He had raised the lid of the tank-box when the wind blew it down on his right hand, bruising it badly. No bones were broken.

Philadelphia, Pa., December 2.—A misplaced switch caused a wreck at the Broad Street Station of the Pennsylvania Railroad this evening. A train from the Schuylkill Division crashed into a number of empty cars which were about to be made up on the main line. Fireman Charles F. Bright jumped from the train when he saw the collision was inevitable, and was slightly cut about the head. The engineer stuck to his post and escaped injury.

Camden, N. J., December 2.—Engineer William Tucker was carried by a runaway engine on the Reading Railroad at the foot of Linden Street into the Delaware River. Tucker managed to crawl out of the cab-door before he became unconscious, and was then helped ashore.

Fort Worth, Tex., December 4.—A locomotive on the Texas Pacific exploded its boiler shortly after noon to-day about a mile west of Eastland. The engine was running about 18 miles an hour at the time. Charles F. Elliott, engineer, and Jesse Beaver, fireman, were instantly killed, the bodies being thrown 100 ft. from the point of the explosion.

Welch, W. Va., December 6.—A freight train on the Norfolk & Western Railroad broke in two when coming through the Flat Top tunnel this morning. The engineer started ahead with the front end to prevent a collision. When passing Cold Dale Station they were running at the rate of 40 miles an hour. On a stiff down grade 500 yds. east of Mayberry, the engine jumped the track between two trestles, upset, and killed Engineer Stocker and Fireman Hain. The two men were killed almost instantly, and their bodies rendered almost unrecognizable by the escaping steam, which scalded them and drove the dirt under their skin.

South Norwalk, Conn., December 6.—An engine and five cars of the Pittsfield freight, bound north on the Danbury & Berkshire Division of the Consolidated Road, ran off an open switch at Bethel late this evening and were wrecked. It is claimed that the switch was thrown by the running away of a horse. The engineer was slightly injured.

Gardner, Mass., December 7.—The boiler of a freight engine on the Fitchburg Railroad exploded at Baldwinville this afternoon. Engineer Otis was slightly scalded, and Fireman Wight was blown from the engine across two tracks, a distance of 30 ft. He was slightly injured on the back.

Pittsburgh, Pa., December 9.—Barney Burke, an engineer on the Fort Wayne Road, was seriously injured this morning by being caught between cars.

Fort Worth, Tex., December 9.—An engine was derailed in the Fort Wayne & Denver yards this afternoon by a misplaced switch. The engineer and fireman succeeded in jumping, the engineer being slightly injured about the leg.

Denison, Tex., December 11.—E. A. Mather, fireman on the Fort Wayne & Denver Road, was struck by bridge timbers while looking out of the cab window this afternoon. He was unconscious when taken from his seat, and remained so until he died.

Terre Haute, Ind., December 11.—Engineer Michael Barry jumped from an engine on the Vandalia mail train this afternoon. A switching engine had backed on to the main track just ahead of him, and he thought a collision was inevitable. After reversing the engine and throwing on the air-brakes he jumped and was knocked insensible by the fall.

Littleton, N. H., December 12.—A mail train on the Concord & Montreal Railroad was thrown from the track between Fabyans and Wing Road this morning. Andrew G. Pike, engineer, was injured internally, and it is feared fatally. Fireman Miller was scalded, but not seriously.

Allentown, Pa., December 13.—A Lehigh Valley engine crashed into a freight at Chain Dam this morning. The collision was due to the negligence of a brakeman in not signalling the locomotive, the engineer of which was a new man. Fireman Keiper was slightly injured.

Wilkesbarre, Pa., December 13.—A passenger train on the Pennsylvania Road ran into a switch engine near Nanticoke this morning. Engineer Newton Frace had his leg badly bruised. M. McDermott, the fireman, had his wrist sprained.

Lancaster, Pa., December 13.—A collision occurred on the Pennsylvania Road through the breaking in two of a freight train, in which Engineer Lilley was thrown against the side of the car, in which he was at the time, and his left side and face badly bruised.

Lucas, O., December 14.—A passenger train on the Pittsburgh, Fort Wayne & Chicago Railroad ran into the rear end of a freight train near this point to-day. Fireman Martin was badly hurt.

Dunkirk, N. Y., December 15.—A Western New York & Pennsylvania passenger train crashed through a 20-ft trestle into a creek near Herrick's Roads this evening. Benjamin McLane, engineer of the train, had his ankle sprained.

Harrisburg, Pa., December 15.—Frank B. Weaver, a Pennsylvania Railroad fireman, was seriously injured at Parksburg to night. He had temporarily changed places with the front brakeman, and while applying a brake the chain broke. He was thrown from the car by the whirling of the brake. He had three terrible gashes on his head and a fourth wound above the right eye. His back was also severely hurt.

Terre Haute, Ind., December 16.—Two freight trains collided on the switch tracks of the Big Four Railroad at Grant Station to-night. The engineers and firemen jumped and escaped with slight injuries.

Louisville, Ky., December 17.—A section of the freight train on the Chesapeake & Ohio on the Southwestern Railroad was wrecked this morning. The engine and four loaded flat cars were thrown down a steep embankment. Thomas Keegan, engineer, and Jack Downs, the fireman, were killed.

Indianapolis, Ind., December 18.—An extra freight on the Indiana & Vincennes Road ran through an open switch near Centerton, 20 miles west of this city, this evening. The switch had been left open. The engineer and fireman jumped and escaped with slight bruises.

Milwaukee, Wis., December 18 —A switch engine on the Chicago, Milwaukee & St. Paul Road ran into two sleeping-cars this evening. Engineer W. W. Cunningham was slightly injured.

Augusta, Ga., December 21.—A fast passenger train on the Richmond & Danville Railroad ran into a local freight train on a siding at Graniteville to-day. The engineer, Ficklin, and Fireman York were thrown through the cab window, Ficklin being horribly scalded by escaping steam. Engineer Hughes and Fireman Allen of the freight leaped through the cab before the collision.

New York, N. Y., December 22.—Henry Stanford, a fireman on the New York Central Railroad, while walking along the top of the train was knocked off by a low bridge at One Hundred and Sixty-fourth Street. He was picked up bruised and unconscious, his skull having been fractured.

Philadelphia, Pa., December 22.—A collision occurred on the Philadelphia & Baltimore Central Railroad at South Street Station this evening. An east-bound passenger engine ran into a large coal car. Engineer Ed. H. Brown and Fireman Larry Doran were badly bruised.

Coatesville, Pa., December 25.—A collision occurred between two engines on the Pennsylvania Railroad this morning. John Michael, an engineer on one of them, was seriously injured.

Ashland, Wis., December 26.—A freight train on the Duluth, South Shore & Atlantic Railroad was derailed near Trout Creek to-day, and the engine and six cars went down an embankment 30 ft. high. Engineer Mulford died a few minutes after being taken from the wreck.

Roanoke, Va., December 27.—A vestibuled train on the Norfolk & Western Railroad ran into an open switch at Troutville yesterday morning. It collided with a freight train. J. L. Olney, engineer of the passenger train, and Fireman J. C. Childress were severely hurt by jumping.

San Antonio, Tex., December 28.—A bolt driven into the point of a split switch at McDonough on the Southern Pacific

Railroad this evening caused an east-bound freight train to leave the track. The engine turned over on Engineer Taylor and Fireman Turner. Turner's legs were crushed and he will die. Taylor was badly bruised.

St. Paul, Minn., December 30.—A train on the Northern Pacific Railroad ran into a deep snowbank between Boulder and Elkhorn to-day, the engine and tender being jack-knifed. Engineer Dennis G. Delay had both legs amputated below the knees. Fireman John Regan was crushed about the left leg and spine.

Springfield, O., December 30.—A collision occurred between a local passenger train at Quincy, O., on the Ohio Southern Road, to-night. Ed. Jackson, engineer, and Thaddeus Jones, fireman, were killed

Our report for December, it will be seen, includes 31 accidents, in which six engineers and six firemen were killed, and 20 engineers and 15 firemen were injured. The causes of the accidents may be classified as follows:

Boiler explosions	2
Breaking through trestle	1
Caught between cars	1
Collisions	11
Derailments	4
Falling of tool-box lid	1
Jumping from engine	1
Misplaced switches	4
Runaway engines	2
Running into snowbank	1
Struck by obstruction	2
Thrown from train	1
	31

DETENTIONS TO TRAINS FROM FAILURES OF PASSENGER LOCOMOTIVES.

We are able to give herewith a tabular statement of locomotive failures on another prominent road in which the data is given in a somewhat different form from those heretofore published in these pages. The table will repay study and discussion, and criticism is invited.

STATEMENT OF PASSENGER TRAINS FOR NOVEMBER, 1893, AND FAILURES OF PASSENGER ENGINES IN SAME SERVICE ON DIVISIONS G, H, AND I.

Cause.	G.		H.		I.		Total No.	Total Time Lost.
	No.	Time	No.	Time.	No.	Time.		
		Min.		Min.		H. M.		H. M.
Air-hose bursting	...	...	1	19	2	22	3	41
Air-pump giving out	...		2	45	1	....	3	45
Air-drum whistle	....	....	1	30	...	....	1	30
Ash-pan	....	....	....	..	1	5	1	5
Brake disconnected	....	....	1	3	...	....	1	3
Cylinder bridge	...	...	1	30	....	....	1	30
" head	2	18		...	1	39	3	57
Crank-pin hot	....	...	1	5	2	45	3	50
Driving-box hot	2	25	2	43	13	2 20	17	3 28
Engine-truck hot	....	....	....	....	2	...	..	....
Exhaust nozzle	....	....	1	20	....	....	1	20
Follower bolts	1	10	....	....	....	....	1	10
Flues leaking	....	....	1	3	2	34	3	37
Fire-box staybolts	..	....	1	25	....	....	1	25
Injectors	....	..	2	29	1	5	3	34
Injector hose uncoupling	....	....	1	6	....	....	1	6
Lubricator glass	....	....	....	....	2	20	2	20
Main rod strap	1	18	...	....	....	....	1	18
" " key	...	....	1	12	....	....	1	12
Packing ring	1	7	...	....	....	....	1	7
Piston-rod	....	....	....	....	1	40	1	40
" gland	...	...	1	5	....	....	1	5
Rocker arm	1	18	....	....	....	....	1	18
Side rod broken	....	....	....	....	1	....	1	....
Spider	1	69	...	....	1	....	2	69
Spring hanger	....	....	1	45	....	....	1	45
Tender-box hot	2	12	3	65	7	85	12	2 42
Valve seat	1	....	....	....	....	....	1	....
Water scoop	....	....	3	15	1	....	4	15

Division.	Total No. Trains.	Total No. Miles.	Total No. Failures.	Total Time Lost.
				H. M.
G	2,349	95,283	12	2 57
H	3,272	250,111	24	5 40
I	2,449	182,199	36	7 51

METAL UNDERFRAMES FOR FREIGHT CARS.*

By G. R. Joughins.

The paper which I have the honor of reading before you to-night is one giving a short history of the experience which the Norfolk & Southern Railroad Company has had with some iron tubular cars, and also describing an experimental steel car designed and built at their works. It was with a great deal of hesitation we made a request to take up the time of this club, but it was with the hope that we could make a contribution of some value, however slight, on the subject of steel freight cars, a subject which, we believe, will soon assume an important place in the railroad economy of this country.

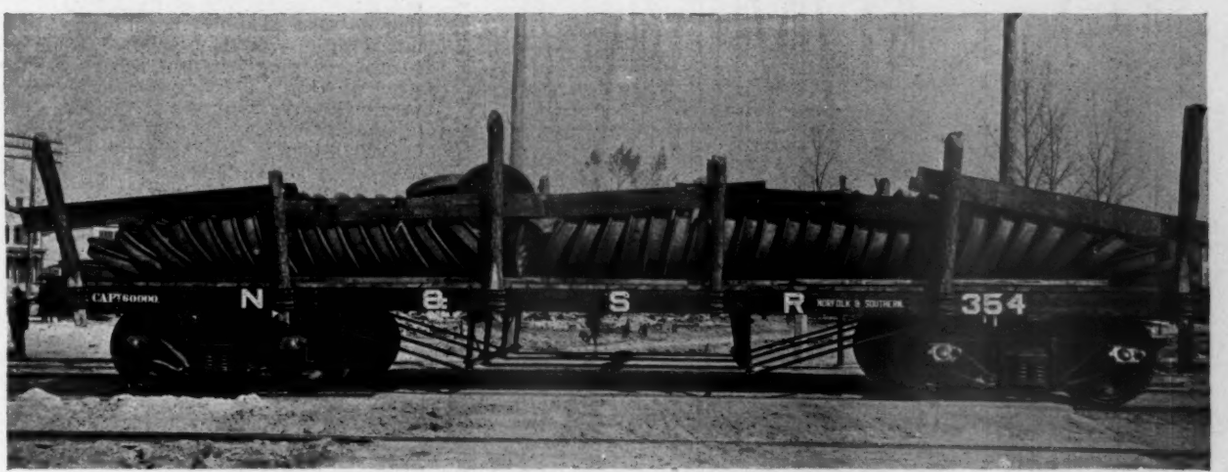
The railroad with which I am connected was opened in 1881. It runs from Norfolk, Va., along the sea-coast for some distance south, through a country which is intersected by wide rivers, bays and sounds, and in which the air is very heavily charged with moisture. A very few years after the road was constructed it was found that all timber, of whatever kind or quality, which had been placed in exposed positions, either in the track, on rolling-stock or steamboats, was decaying very rapidly. As soon as the fact that the climate was so peculiarly destructive to timber was observed by the officials, they became anxious to avoid the use of material which so quickly deteriorates; and, in connection with the rolling-stock, the Iron Car Company's cars were brought to the notice of the General Manager. The result was that in August, 1888, we leased from that company 50 of their flat cars for a period of five years, hoping by actual experience to determine what benefits might be secured from the use of iron frames instead of wood. Many members of this club are more or less familiar with the cars of which I speak, and have had more or less repairs to do upon them; I think, however, that very few have had the time or opportunity to look at this car in detail, to have it every day within their sight, or to see it under the most favorable circumstances; and are therefore not sufficiently familiar with it to be aware of its good features and to know exactly what its deficiencies really are. I have been looking at these cars nearly every day for the last three and a half years, and feel compelled to say that it is very seldom indeed I have come across a structure in which the details are so well designed as the details of these cars. It appears to me that the draftman was an artist in metal, he showed a profound knowledge of the art of designing malleable iron castings; every detail of the car has been formed on the most correct theory by some one who possesses an artistic eye competent to combine beauty and strength, and who instinctively cut away every ounce of superfluous metal. I feel that I cannot too much admire the cunning of the hand which molded these different details, and adapted them so perfectly to the strains which they are called upon to withstand. (I have here some examples of these details which will, I believe, bear criticism and prove my praise to be deserving.) Another excellent and very important feature of these cars is the method adopted for attaching the various parts together: everything is held in place by bolts and screws, and after five years' service I cannot find a piece loose, nor is there a single hole which is visibly worn out of shape; a gratifying and successful result which would have been impossible to obtain if rivets had been used to join any parts whatever. When I speak in this favorable strain of the tubular iron cars, I am sure that some of the members will be unable to understand why I should bestow a word of praise upon them—that is, because they have not had the opportunity to distinguish between their design in detail and their design as a whole. I understand that very few railroads can find a good word to say in their behalf, and that they must prefer seeing them on their neighbor's track instead of on their own. This is because the car possesses some defects in general design which are fatal to its successful use under the heavy handling which cars receive on railroads at the present day. I believe it was able to stand the shocks received by cars a few years ago, before the era of heavy motive power and improved draft-rigging, and before the yardmen found out how much more the improved appliances would stand without visible breakage. These weaknesses mostly arise from a very radical departure from previous practice, which the original designer or inventor of this car saw fit to make, by reducing the number of the sills, and by introducing new and untried attachments for the draft-gear. The car was also, I believe, designed to catch a wave of popularity. It was something which could be talked about in a fascinating way, as the tubes of which it is constructed represents to the mind of the uneducated engineer the greatest possible com-

* Paper read January 18 before the New York Railroad Club.

bination of strength and lightness, a fallacy which is a very popular article of belief among laymen. You are probably aware that the sills are constructed of eight tubes placed to form four sills, and designed to carry 60,000 lbs., but they are altogether too weak to support such a load, and when the car is loaded uniformly to its full capacity, the sills assume a sinuous or curved line which immediately show their inherent weakness; and when the car is loaded heavily at a point about midway between the supports of the sills, then they are certain to bend badly, and show far more deflection than wooden sills under a similar load. Another great mistake (the greatest mistake of all) was made by using four sills instead of the six, which we are accustomed to use in cars made of timber. It was evidently done to enable the builder to produce a car which would be light compared to the load which it was intended to carry. It was, however, a very grave error to lower its strength so much as to imperil its future for the sake of a few pounds in weight; the absence of centre sills necessitated some new design of draft rigging, and the unusual step was taken of constructing it so that all the pulling strains were taken directly on the end sills, and all the buffing strains on the body bolster, parts which were not made strong enough to withstand the heavy service on large roads and which consequently are nearly always in a state of collapse. There is also a peculiar arrangement of tail bolt and cotter which gives a great deal of trouble. This draft-gear and the means of fastening it to the cars form the most fatal objection to their use, they are the parts which first give out under the heavy strains, and they are a constant source of annoyance on our large railroads, at least where heavy cars and big engines are used. In every-day service it was therefore soon found out that the car was deficient in strength in the places named, and that when they failed, much difficulty, trouble, and annoyance were entailed in repairing them. It was also found that the parts required for repairs were special to this car, had to be obtained from the manufacturers, and were difficult and tedious to procure, so that a damaged car often took up room in the repair yard of a foreign road for several weeks, producing irritation in the minds of the officials, and giving another serious cause of complaint against the iron cars.

In the *Railroad Gazette* of May 26, 1893, there is an editorial headed "A Suggested Economy in Freight-Car Repairs," in which the writer calls attention to the heavy damages sustained by cars in the yards, and forcibly expresses his opinion that they are unnecessary and could be saved by judicious control. How far the idea upon which it is written could be carried out on our larger roads I do not know. Our railway is a small one, not overcrowded with trains, and we are therefore able to carry out the policy indicated. We have done so for years, every case of damage to cars is investigated, and if caused by the carelessness or stupidity of any employé some punishment is awarded; while, as an incentive to care for the company's property, and to take a personal interest in its protection, quarterly premiums are awarded to the train hands giving the most satisfactory service. The consequence of this watchfulness on the part of the management, combined with the influence of local conditions, has been very propitious to the iron tubular car, it has been operated under the most favorable circumstances, with the result that we are, I believe, the only railway which has made a success of it, and we have made it a great success. We are very much gratified with its performance, and are well assured that we have obtained large reductions in cost of maintenance compared with the cost of cars having timber frames.

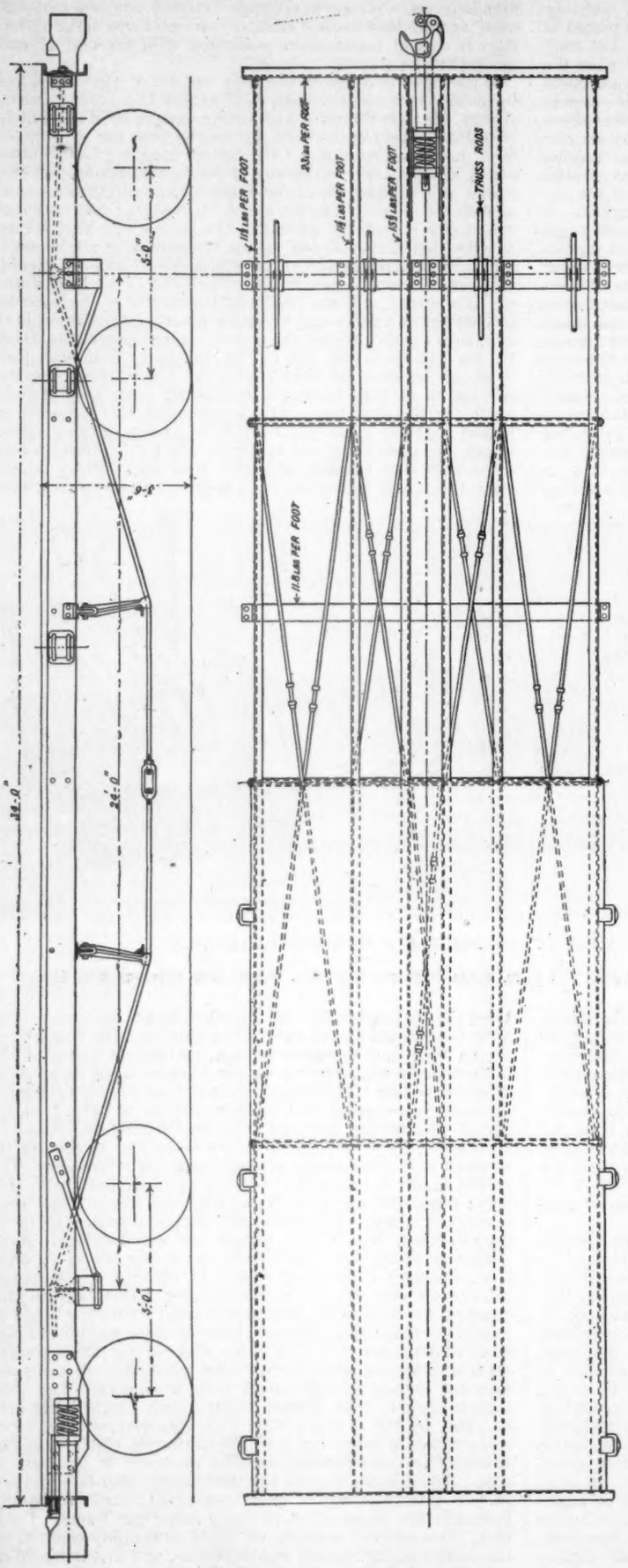
With the experience obtained in the use of these cars, and by acting upon the suggestions of others in relation to metal frames, we have designed and built a sample steel car which, we think, is very much superior to the iron car of which I have just been speaking. We believe that we have built a car in which all the weaknesses of the tubular frame are obliterated, and against which very few of the objections raised against the iron car can be urged; indeed, we feel sure that it is strong enough to withstand the strains to which it may be subjected on any of our railroads, and that it can be maintained in good repair for an indefinite period with an exceedingly small annual expenditure. The experimental car which we constructed, and the design of which I have the honor of placing before you to-night, has six longitudinal sills made of 8-in. steel channel beams, the side and intermediate sills weigh 11½ lbs. and the center sills 15½ lbs. per foot. The draft-gear is placed between the center sills, not below them, the end sills are 12 in. deep so that a sufficiently large hole may be made for the drawbar. The longitudinal sills are tied or braced together transversely by bolts having distance pieces of gas-pipe upon them, and longitudinally by diagonal tie-rods fitted with turn-buckles, and with their ends strung on the same transverse belts with the gas-pipe distance pieces, thus



STEEL CAR, DESIGNED AND BUILT BY THE NORFOLK & SOUTHERN RAILROAD.

TEST LOAD, 147 CAR WHEELS, WEIGHING 80,000 LBS. AFTER TEN DAYS, TOTAL DEFLECTION 5/16 INCH. PERMANENT DEFLECTION, 1/4 INCH.

tying the six longitudinal sills together in each direction. The body bolsters are of the well-known plate pattern which have been a long time in successful use, the bottom plates of the bolsters being supported by diagonal braces to the center sills. The connections between each sill and body bolster to sills are all made by the use of steel angle irons 3½ in. × 3½ in. × 7/16 in. and of ¾-in. turned bolts put in a good driving fit. The sills are trussed by four rods 1⅛ in. diameter, and having 1¼ in. screwed ends with heavy wrought-iron plate washers. The needle beams are steel ties 5 in. × 3½ in. bolted to the side sills; the struts are of malleable iron, the whole truss being made very deep. The draft pockets are intended to be of pressed steel, but in this sample car are forgings. Each pocket is bolted very securely to the center sill by 10 bolts 1 in. diameter turned and driven in, forming the strongest attachment ever applied to an ordinary freight car in this country, the bolts being able to withstand a shearing strain of nearly 400 tons; the follower plates are made as short as possible, of wrought iron 2 in. thick, the regular Pennsylvania Railroad standard draft spring being applied, with a supplementary buffing spring behind horn of coupler. The platform is made in four distinct lengths, each length being held in place by six or eight bolts ¾ in. diameter, so that when these bolts are taken out a whole section of platform can be lifted off for examination, painting, or repair of platform or sills. The designs for this car were made after laying down certain principles which, I am persuaded, ought to be embodied in the construction of every metal car frame. I felt that, if we adhered to them, we could with safety count upon the service which the car would give us, and that it would be entirely satisfactory. These principles were:



IRON CAR, BUILT BY THE NORFOLK & SOUTHERN RAILROAD; G. R. JOUGHINS, SUPERINTENDENT OF MOTIVE POWER.

§1. That the car should be made amply strong enough to support the weight it was designed to carry; 2. That only the common rolled sections of steel or plain forgings should be used, except for the draft pockets and such details as are special on timber cars; 3. That no rivet should be used in its construction; 4. That no holes whatever should be allowed in the flanges of the beams; 5. That all work should be first class, equal in quality to locomotive work; 6. That the ultimate weight and cost of the car should be entirely secondary considerations. The first requirement, "That the car should be made amply strong enough to support the weight it was designed to carry," was understood to mean that it should be quite capable of carrying a load equally distributed over the platform equivalent to the rated capacity. This was carried out by selecting channel irons of such a section that the six sills combined are able to carry with perfect safety a distributed load of 400,000 lbs. on supports placed 1 ft. apart. To impress upon you the great difference in strength between this steel car and the tubular car, I must tell you that this weight is 16 times as much as could be supported under the same conditions by the eight tubes composing the sills of the tubular car; and this advantage is mostly obtained by putting the same weight of metal per foot of sill into a better form, the balance of the increased strength being gained by using six sills instead of four. This comparison shows up very vividly the weakness of the sills in the tubular car and explains why the tubes so soon become distorted. In trussing the sills of our steel car advantage is taken of the space beneath to make the truss very deep. It is 21½ in. below the sills, and its total depth is 28 in., which is, I think, greater than any hitherto used in car work. The truss-rods are calculated as the tie-rods of a queen truss, and therefore perform their proper function of entirely supporting the load between the bolsters, and are strong enough to sustain their share of a distributed load of 80,000 lbs. on the car, therefore making this a frame of 80,000 lbs. capacity. In fact, the frame can easily be converted into one able to support 100,000 lbs. by simply strengthening the tie-rods and struts. As it can be proved that the free ends of the sills which overhang beyond the body bolster, and which are the weakest part of the car because they cannot be trussed, have a combined strength sufficient to carry their proportion of an equally distributed load of more than 100,000 lbs. over the whole platform; and if the truss were made heavy enough a safe load of 190,000 lbs. could be piled upon this car, an enormous load compared to the net weight of the car. You may notice that the struts are inclined to the vertical, so as to bisect the angle formed on the tie-rods, the change from the usual practice being made because it is more correct in theory and more in conformity with the strains transmitted. You may, perhaps, ask me why I have made a frame capable of supporting so great a weight. I would reply that a car is called upon to resist many heavy strains beyond those required to support its load. It has to stand buffing and pulling strains, corner strains, side strains, torsional strains on side sills, strains reaching through the truck, and many others, all of which have their effect upon the various members, which must be made strong enough to absorb them. Besides that, I think it would not have been wise to use smaller or lighter beams; the saving effected in weight by using 6-in. beams instead of 8-in. would have been only about 600 lbs., and the reduced cost very little indeed. I merely mention the enormous weight which the car would carry to show what can be effected by using economical sections in the beams and by proper and efficient trussing.

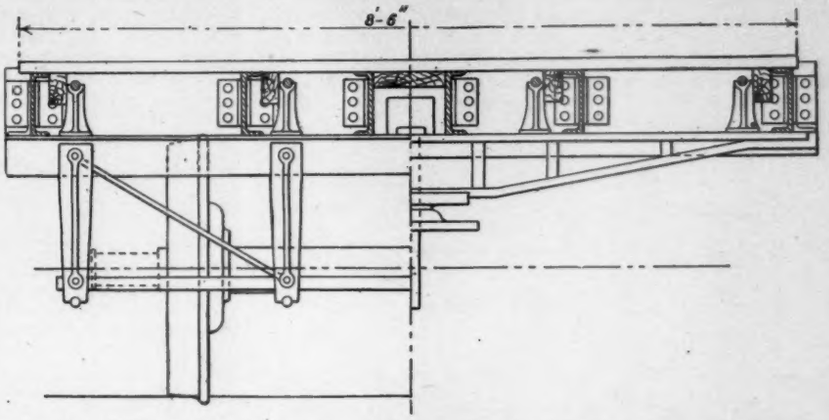
The second principle, "That only the common rolled sections of steel or plain castings

or forgings should be used," needs no explanation, and I think we have succeeded in fulfilling the requirement.

Before laying down the third principle, which says "that no rivets whatever should be used in its construction," much consideration was given to the question, "What is the most desirable, efficient, and durable fastening for attaching together the various members of a steel under frame?" This, to my mind, was the most important question involved in the details of the car, as upon its successful solution depends the very life of any metal under frame which we may attempt to construct. The question is one which at first sight appears to have only one answer, and that is to use rivets. From the remotest times rivets have been used in all countries for fastening together pieces which were required to be held together in the tightest possible manner. We build our boilers, our bridges, our ships with them; and many examples could be pointed out in the practice of other countries—and, indeed, in our own—where rivets have been more or less successfully used for this very purpose of fastening together details of rolling stock. But I felt that the conditions obtaining in metal under frames in this country were different from the conditions obtaining in other previous structures. I also have had experience with tender frames and freight-car trucks, and could only come to the conclusion that rivets are not reliable, unless certain conditions, which are very difficult to fulfil in a metal under frame, are complied with. These conditions are, that the joints or connections between the several pieces should be made large so that many rivets could be used, and that all rivets should be put in by machinery, in order that they may support each other and prevent that first small movement which is so fatal. I know that riveted structures can be pointed out on every side in which rivets prove themselves perfectly good for all time, but I submit that the conditions which rivets are required to meet in boilers, bridges, etc., are altogether different from the conditions they would be asked to meet in car work. In the permanent structures mentioned there is a very large number of rivets and very little vibration; in a car frame, and especially the long car frames of this country, the vibration is very great, and the rivets connecting each joint must necessarily be few; there would be a great number of intermittent stresses put upon each rivet, gradually lessening them one by one. I distinctly admit that this would not occur if sufficient rivets could be used, and it is one of the good points of design in the Fox truck that very large joints are made and plenty of rivets used, in contradistinction to the small number of rivets which are often used in the diamond style of truck, and which are so difficult to keep tight, there are not enough of them, they do not support each other, and in consequence become loose in a comparatively short time. As black bolts are evidently out of the question, the only conclusion which could be reached is that the most desirable, efficient, and durable fastening from every point of view would be turned bolts having a good driving fit, the workmanship required being equal in all respects to that put upon our locomotives, which would mean that not the slightest degree of looseness could be found in the structure. The use of such bolts would also include a number of other advantages when the cars are in service and when they require repairs; and, finally, it can be easily shown that they would be cheaper and lighter than rivets, because the joints would not require to be so large nor the fastenings so numerous.

To prove that turned bolts are perfectly reliable and efficient for continued use in a structure subjected to large and constant vibration, I have only to point to our locomotives and other prime movers, where bolts are subjected to ever-varying strains in intensity and direction in the main rods and other parts, and to the built-up car-wheels which run on all the principal roads of the country. I am particularly indebted to Mr. Boies, of the Boies Steel Car-Wheel Company, for describing the bolt which he uses for attaching together the two thin plates forming their built-up wheel, and which I have adopted in a modified and cheaper form on this car by making the bolts parallel instead of taper. The principal feature of this bolt is that the body is made long enough to be a driving fit completely through all the plates which are to be connected together, so that, however thin the pieces are, the body of the bolt fits perfectly tight into each piece, the screwed part therefore projects beyond, and the nut is countersunk enough to allow it to be tightened up. Mr. Boies takes extraordinary precautions in the fitting of the bolts, and says that he does not recollect ever having heard of a nut unscrewing or coming off, but the usual method of fitting driving bolts would, of course, be all that is requisite for car work.

The fourth principle laid down is, "That no holes whatever should be allowed in the flanges of the beams." This requirement is, I believe, of the utmost importance. It can be easily seen that if a hole be drilled through the flange of a channel iron its strength is very greatly reduced, but I believe that much more mischief than the weakening of the beam would ensue. I feel sure that wherever a hole is in the flange that ultimate breakage is certain to result, starting from that hole. This is especially true of steel beams. It would be exactly like nicking a bar of steel, the serious effect of which is so well known, and the beam would act in precisely the same way, subjected as it would be in car work to great vibration. Some new ideas in car construction are therefore introduced for fastening the platform and under rigging to the main frame.



END ELEVATION AND SECTION AT BODY BOLSTER OF N. & S. R.R. IRON CAR.

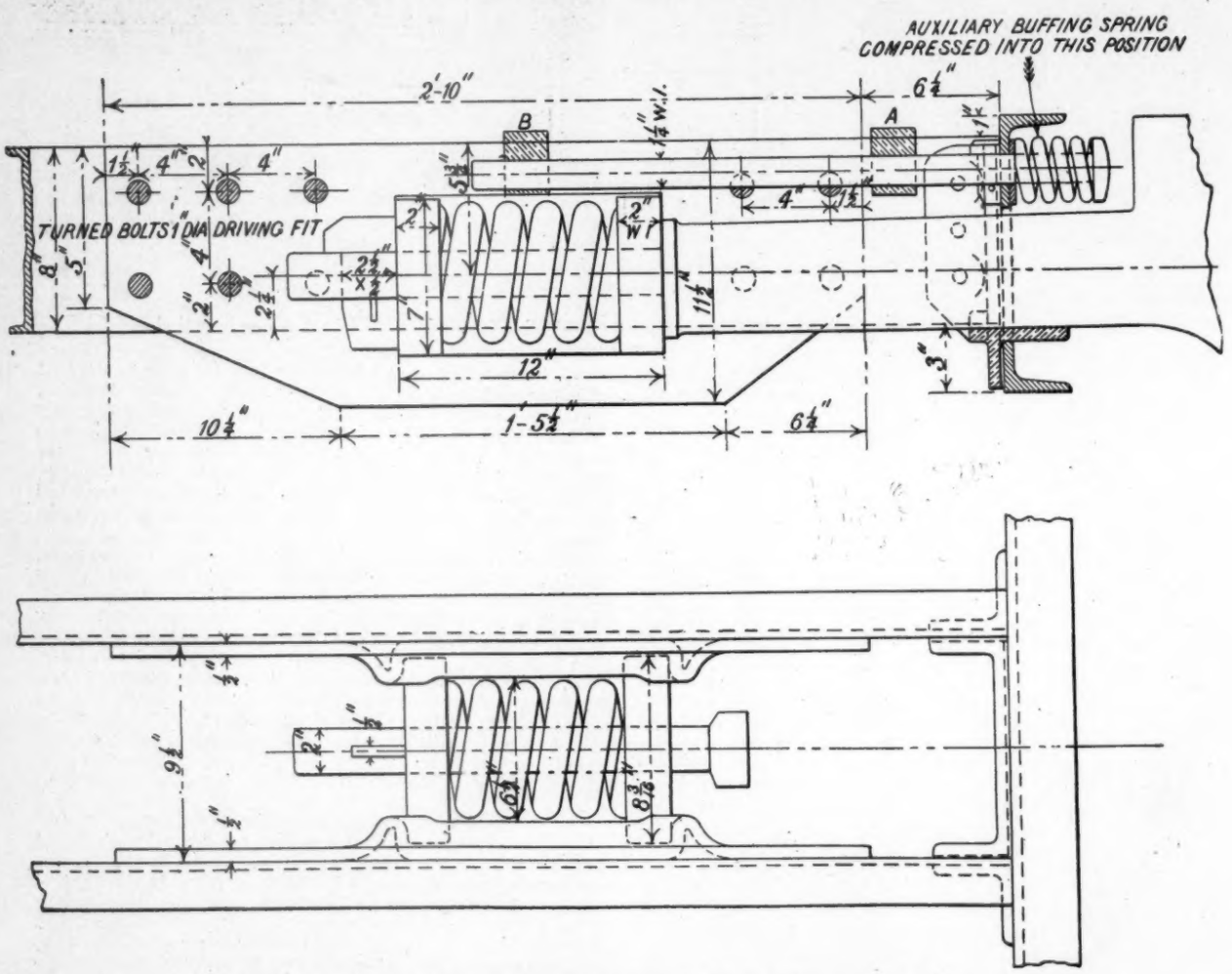
The fifth requirement, "That all work should be first class, equal in quality to locomotive work," speaks for itself. That the expense would be justified by results I am well convinced, but the extra cost need not be great, the requirement only means that extreme care be taken to make the first few cars with strict exactness, that the parts should be perfectly interchangeable, that the holes should be made an exact size, and the bolts properly turned and fitted. Such work can be done very cheaply. With suitable tools and proper organization holes can be drilled for one-quarter cent each, and bolts can be finished from the forge at less than one cent each, an increased price over black bolts not worth a moment's consideration.

The sixth principle, "That the ultimate weight and cost of the car would be entirely secondary considerations," is, of course, to be understood as within reasonable limits. It was laid down to try and escape as much as possible the temptation to make everything so light and cheap that there might be some doubt about its efficiency; in other words, the dominant idea was to be certain to make everything strong enough, leaving the future to disclose what parts might be made lighter and what braces and details might be dispensed with. The result, so far as the weight is concerned, is certainly very satisfactory, the frame with platform weighing only 2,000 lbs. more than the frame of the tubular iron car, the total weight (without brakes) being 20,300 lbs.

Respecting the cost, I would say that we intend soon to get some cars made exactly the same as this experimental one. We therefore sent specifications to some makers, and were agreeably surprised to find that, although the car is an entirely new departure, yet the figures submitted agreed, as near as possible, with the cost which we had estimated they could be built for. We think these figures are very reasonable, and so long as we can get metal car frames made at such prices, we shall never desire to buy wooden ones.

The first test of this experimental car was made by placing upon it, as its first load, 147 car-wheels weighing 80,000 lbs., leaving them there for 10 days, and in the mean time moving the car several times through the yard and to the scale track 1 mile away. At the end of this time the sills were found to have a total deflection of $\frac{1}{4}$ in., and when the load was removed a permanent deflection of $\frac{1}{8}$ in., amounts which are very small and which show the great strength and rigidity of the frame.

The car has now been in constant use for 14 months, and has given very satisfactory service. Not one cent has been expended for repairs, and not a single bolt or nut has yet become loose. As our idea in building this experimental car was to discover weak places before ordering a number, we have had it in the shop many times for examination, and can only discover one weak place—that is, a slight deficiency in resistance to torsion of the side sills; they are twisted a little by heavy loads of pine logs, three or four tiers high, which wedge themselves down against the stakes, producing a large twisting movement, but this deficiency can be very easily overcome. We also find that the castings protruding through the end sills for supporting the drawbar are broken, but the breakage is not significant, and was caused simply by using iron castings instead of steel ones, as intended. These are absolutely the only defects which we can find, and they do not affect the principle or ultimate value of the design in any way whatever.



DRAUGHT RIGGING OF IRON CAR ON THE NORFOLK & SOUTHERN RAILROAD.

I believe that the advantages to be derived from the use of steel car frames are manifold, and of importance to all railroad companies. It is certain that on our railroad, and in such a climate as ours, we feel well assured that steel possesses great superiority over wood in strength, cost of maintenance, and endurance, and that it is the only material which we could consistently use in the future for frames of all flat and gondola cars, and probably for box cars. We consider that we have proved completely that it has the advantages claimed. With such a frame we should be well prepared for the next demand for increased capacity, and I would feel inclined to strongly advocate that trucks of 80,000 lbs. capacity should be placed under these frames, even though it might not be desirable to carry such loads at the present time. I am also deeply imbued with the belief that on nearly every railroad in this country steel frames could be successfully used, and that increased economy, efficiency, and durability would follow their adoption. I do not mean to say that other railroads could secure the gratifying results in the use of tubular iron cars which we obtained, but, as a result of our experience, I unhesitatingly express my profound convictions that steel frames can be designed and built which will secure these advantages on any road, that designs will develop for cars possessing greater strength and efficiency as experience dictates, eliminating the weak points, and proving that steel is the only material which ought to be used for this purpose in this age of steel. I am convinced that the cost of repairs could then be reduced to an extremely low figure. There is nothing to wear out except the running gear, nor is there anything but the platform and paint which will deteriorate by age. The period of their life would depend simply on questions of improvement, of heavier weights to be carried, and on the fashions of the times, otherwise the metal car has an indefinite life, great strength, and unlimited endurance.

Mr. President, I am not alone in believing that there is a great future for the steel car frame. I can refer to our technical papers, which go so far to mold the opinions of every railroad official. They seem to be unanimous in advocating its possibilities. *The Engineering News* of May 19, 1892, has a very able editorial on "The *Pros* and *Cons* of Iron Car Construction," in which the writer shows that iron cars are economical because they reduce the dead weight to be hauled, independent of all questions of reduced cost of maintenance, and says: "Those facts lead us to believe that steel car construction has come to stay and to rapidly increase . . . and with a capacity of perhaps 100,000 lbs. With such cars, all equipped with train brakes and close couplers . . . freight rates may touch depths not dreamed of yet, and still leave a larger profit on each ton handled than is realized to-day." *Locomotive Engineering* for August, 1893, has an editorial headed "Steel Under Frames for Cars and Tenders." The argument in favor of steel frames is put very forcibly and concisely. It says: "When the strength and durability of steel is compared with wood, it seems strange that car builders on this continent

have done so little to apply the stronger material to the principal members of a freight car. . . . We believe that the subject needs to be agitated, and that railroad companies would be the gainers by extended investigation and discussions on the subject of metallic under framing." *The Railway Age and Northwestern Railroader* says: "The tendency toward the use of metal is seen in car framing, and while not particularly exemplified in practice, is still strongly revealed in the current opinion and talk of some of our best mechanical officers . . . the car made in its practical entirety of steel is to-day considered as well within the range of probabilities for the comparatively near future." *The Railroad Gazette*, in an editorial of June 9, 1893, says: "What is most needed to gain the least cost of carriage per ton mile is a set of standard metal frame freight cars with uniform trucks. . . . If some of our progressive roads would take up this matter, and build perhaps 1,000 cars with steel under frames, or at least steel center sills, and do the work in the same thorough way that bridge work is done, there would be within five years' time some practical knowledge of real value that would bear upon the subject and be a safe guide for the future."

At the last convention of the Master Car-Builders' Association the following sentence appeared in the report of their committees: "When metal sills come into use it might be possible, on account of the changes which will be necessary in the draft-gears of most companies, to arrive at a standard. . . . We believe the time for the substitution of metal sills is approaching." We know that in some foreign countries steel under frames have been successfully used for many years, and in response to my inquiries the President of the German Railroad Commission writes in reference to steel frames for cars: "Such a construction is unchangeable, and is stiffer than that of wood, besides being perfectly fireproof, while the expense of maintenance is less." The Superintendent of Motive Power of the Western Railroads of France says: "I have the honor to inform you that metal frames have been substituted in an almost general manner for wooden ones in cars of recent construction." Perhaps the strongest argument which I can present for metal under frames is a copy of the statement which influenced our opinions and determined our conclusions in favor of metal cars. The statement shows the repairs executed from April, 1890, to April, 1893, on the 50 cars which we had leased from the Iron Car Company, and the cost of these repairs. It will be seen that two cars were wrecked. With that exception you will notice the light character of repairs executed, and the fact that absolutely none were required upon the under frames. This good record was made in face of the fact that the cars have during the whole five years been carrying heavy loads, and always run in trains containing 50 or 60 cars. Nor must it be supposed that the frames required repairs which they did not obtain; on the contrary, the cars have been always in good condition, and the frames for all practical purposes are as good as new. At the end of our lease, in August last, these cars were inspected by Mr. C. W. Walker, Master Mechanic of the Seaboard & Roanoke Railroad, and Mr W. A. Brown, Master Mechanic of the Atlantic & Danville Railroad. Their report shows that the only defect which existed in the under frames was one damaged tube or sill.

The total cost of repairs to these 50 iron flats for three years, leaving out wrecks, wheels, and brasses, has been $163.32, an average of $1.10 per car per annum. I must say, however, that the timber platforms will soon require thorough repairs, and the iron work needs a coat of paint.

For the purpose of contrasting our experience with metal frames with the experience of other people having timber flat cars, I made numerous inquiries with the hope of obtaining the cost of maintenance of such cars, their average life, and the percentage of repairs and rebuildings due to wrecks, but was unable to procure any information from which general conclusions of value could be drawn. The average life of such cars was given as from seven to 17 years; and in reference to the percentage of repairs and rebuildings due to wrecks, I can only quote what was said by Mr. Barnes at the last Master Car-Builders' Convention, that it amounts to 6 per cent. on large roads. Therefore the only statement which I can submit as to the cost of repairs of wooden cars is one from my own road showing cost of maintenance for 50 wooden cars for the same three years. I must, however, say that these timber cars were three years older than the iron ones, and the peculiarly destructive effect of our climate must not be forgotten. This statement shows the total cost of repairs to 50 wooden flats for three years, leaving out wrecks, wheels, and brasses, has been $2,664.49, an average of $17.76 per car per annum, 17 times as much as the iron cars which, I think, gives a sufficient reason for our preference in favor of these cars, and proves conclusively that metal frames are superior to wooden ones, if only they are built to suit the heavy traffic of to-day, and with strength commensurate to the work and abuse to which they will be subjected. If they are built strong enough it is difficult to predict how far-reaching the results from their use may be. The latent possibilities of the steel car are unlimited, and it is certain to triumph in the end; and if I have induced you to look at this question from my point of view, it only remains for you to consider whether the time has yet arrived for the general introduction of steel cars on the railroads of this continent, or whether the work is to be left for the next generation to accomplish.

MARINE NOTES.

Unsafe Gunboats.—The report of the Naval Stability Board, that was appointed to inquire into the defects on a number of the war ships, has been submitted to the Secretary of the Navy in reference to the *Machias* and *Castine*. The Board said that these gunboats are top-heavy and unstable and recommends that the two vessels shall be lengthened 14 ft. The estimated cost of the alteration is $30,000.

The Proper Color for Torpedo Boats.—Germany's naval experts have decided that the best color to paint their cruisers and torpedo boats, in order to make them as difficult of observation as possible, is a kind of dirty buff. They recommend that the whole of the vessels should be uniformly coated with this color, and that nothing on their decks or upper works should contrast with it.

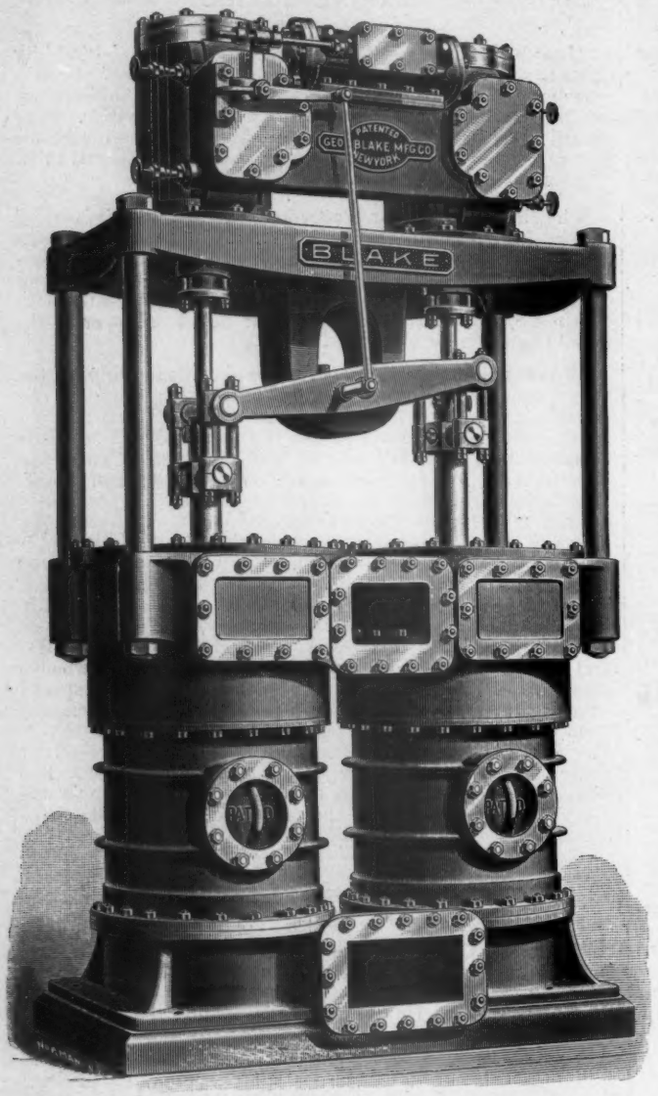
Wooden Ships in the Navy.—The old wooden ships of the Navy are gradually being retired from active service. The flagship *Lancaster* is now on her last cruise. When relieved by the *Baltimore* she will return to New York and be transformed into a receiving ship, to take the place of either the *Minnesota* or *Vermont*, which are both in a state of decay. Another ship that will soon follow the *Lancaster* to the graveyard of all old naval vessels is the *Alliance*, now at San José. She will leave in the next few weeks for New York, and is also to serve as a receiving ship. The *Marion*, *Mohican*, *Adams*, and *Yantic* are still in service, but their days are numbered. The *Yantic* is in the South Atlantic, and will return home shortly to be placed out of commission. She is now on her last cruise. The *Adams* is not good for many more months, and the *Marion* is little better. There will be two wooden vessels in the Navy for many years, however, as, by special act of Congress, the *Hartford* and the *Kearsarge* are exempted from the repair limit of 10 per cent., and will thus be saved. The *Hartford* is being rebuilt, and will prove a good vessel for many years, and the *Kearsarge* is now in fair condition. But with the exception of these two every wooden ship in the Navy will disappear within the next year or two.—*Washington Star*.

PROCEEDINGS OF SOCIETIES.

Engineers' Club of Philadelphia.—At the meeting of this Club on January 6 Mr. A. Falkenau described some interesting features in the department of mechanical engineering at the World's Fair. He expressed the opinion that the disappointment expressed by many engineers regarding the mechanical exhibits was partly due, not so much on the part of the exhibitors as to the fact that the different fields of the application of power had been so thoroughly exploited that novel forms are few, and advance is confined to minor details. He gave a full description of the Yerkes telescope, some air compressors, and certain riveting machines.

Engineers' Society of Western Pennsylvania.—At a recent meeting Mr. D. Ashworth read a paper entitled "Indifference to Boiler-firing and Management." He stated that in experience extending over a period of a quarter of a century he had found that there had been a continuous decline in the grade of service of those in the positions of firemen and boiler-room managers, that the evil had become so glaring and the results so palpably fraught with disaster, destruction and waste, as to warrant an effort to call the attention of those who desire to progress to the false and inconsistent position which they occupy, by permitting such a narrow policy in management, so widely at variance with true economy, ignoring directly that the better intelligence renders the more valuable and hence more profitable service. He stated that the intelligent engineer keeps a constant oversight over every part of the steam plant, and is familiar with the elements of com-

bustion and the importance of proper management of fires to produce the greatest results with the least expenditure of fuel. It has been said that this is greatly overcome by the application of mechanical stokers, but this is a mistake well known by those conducting tests, the results being always superior with the greater intelligence of the operator of the machine. What is greatly needed at present is to lay aside the idea that any one is good enough to fire and manage boilers. The reason why a better class of skill is not obtained for this work is that it is not sought, and just as long as this class of operators is looked upon as mere shovelers, throwers of coal and carriers of water, ignorance, with all its attendant waste, destruction of property, and general demoralization, will be prominent in the department. As a fitting close it would be proper



THE BLAKE VERTICAL TWIN AIR-PUMP ON THE U. S. CRUISER "NEW YORK."

to ask what degree of intelligence or knowledge would qualify one to fire boilers properly?

1. That the fire should be maintained with uniformity, and that no openings, in the form of bare places, showed upon the bars to permit cold air to pass through.

2. The judgment that will enable him, by a glance at the ash-pit, to know at once, to a great extent, the condition of the fires.

3. He should know something of the various fittings of the boilers, such as valves, etc., and the details of the furnaces.

But not least, an ambition to grasp the details, so as to qualify him for a still higher plane, which would certainly follow, provided there was judgment enough in the superior to note such details.

Sufficient, we think, has been said to convince the most obtuse mind that the indiscriminate employment of labor for this purpose is a crying evil, and some consideration given to the claims here made, that, simply because one can shovel and throw, it does not follow that he is qualified to fire and have charge of steam-boilers.

AIR-PUMPS ON THE UNITED STATES CRUISER "NEW YORK."

Our readers will remember the illustrations in our last number of the United States armored cruiser *New York*. We now publish particulars of the independent air-pumps, which in their way are quite novel in construction and performance. The cruiser *New York*, like all the Government vessels, has very little room to spare for the engines and their auxiliaries, consequently the design of the air-pump had to be one combining compactness, minimum weight, and maximum efficiency. As shown by the illustration, the design of this pump is of the vertical twin single-acting type, Blake system. The air cylinders are of the well-known vertical, single-acting type, operated by steam cylinders on the direct-acting system; there being two air cylinders, the operation is practically continuous or double-acting. The piston-rod on each side of the pump is connected to the beam by means of links, etc. The air cylinders and the working parts of same are entirely of gun-metal composition, which is the usual practice in the United States Navy. The piston-rods in the steam cylinders, as well as the valve gear, are of steel, and the latter is so arranged that it can be adjusted by hand even while the pump is in operation, thus securing full stroke at all times.

These pumps are particularly remarkable for their economy—that is to say, for the low percentage of the power required in comparison with the power of the main engines. From the official report of the trial trip the indicated H.P. of the Blake air pumps was less than one-quarter of 1 per cent. of the indicated H.P. of the main engines, a result that has, we believe, never before been attained in marine engine practice. The explanation for this small amount of power required to do the work is perhaps due to the very complete and perfect arrangement of the steam valve gear, which thoroughly controls the operation of the pump, so that a very low rate of piston speed is sufficient to give a first-class working vacuum. As an illustration, the average speed of the air-pumps on the trial trip of the *New York* was less than 16 double strokes per minute, while the minimum speed was only 9½ double strokes per minute. The pumps are so positive that they can be run at practically any speed desired without the slightest danger of being caught on a dead center, a feature which, of course, is impossible with a crank and fly-wheel type of independent air-pump. In fact, these pumps have been so successful that the William Cramp & Son Ship & Engine Building Company have placed them on all the other vessels they are building for the Navy—namely, the *Columbia*, *Minneapolis*, *Brooklyn*, *Indiana*, *Massachusetts*, and *Iowa*.

Each of the *New York's* air-pumps has two double-acting steam cylinders 12 in. diameter, two single-acting air cylinders 25 in. diameter, the stroke of all being 18 in.

The working parts of this pumping engine are exceedingly simple and strong. The valves for the steam cylinders are plain D slide valves, which are operated through levers by a supplementary piston moving in the horizontal steam cylinder shown. This supplementary piston is in turn operated by a plain D valve connected to the valve-rod, having adjustable collars for regulating the stroke. This valve-rod is moved by means of the rod attached to the working-beam from which it gets its motion, and which is clearly shown in the engraving.

New Material for Electrodes.—A species of fungus has been found to be well adapted for the making of electrodes for external use in electro-medical operations. Felt, cotton and clay have not been altogether satisfactory for this purpose. The fungus grows on old trees in Europe. When prepared for the above use it has the appearance of soft leather, and is very porous. It is found to be an excellent conductor, and besides readily conforms to the irregularities of the body.

Fast English Cruiser, the "Destroyer."—The Admiralty have placed an order with the Naval Construction Company, of Barrow, for a first-class cruiser. She is to be 300 ft. long, with a speed between 23 and 24 knots.